Fee- based income and macrohedging in Canadian banks

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ABSTRACT

The Canadian banking system has experienced significant changes over the last two decades. Deregulations allowed banks to generate revenue from non-traditional activities, and today fee-based income is as equally important as net interest income. The main objective of this thesis is to investigate how fee-based income affects a bank's earnings volatility and its exposure to interest rate risk.

We conduct empirical analysis of the annual fee-based income earned by the six largest Canadian banks (Royal Bank of Canada, Toronto-Dominion Bank, Canadian Imperial Bank of Commerce, Bank of Montreal, Bank of Nova Scotia, and National Bank of Canada) over the period from 1990 to 2012 inclusive. This analysis shows that almost all kinds of fee-based income generated by Canadian banks are highly dependent on the performance of the Canadian economy. In particular, we notice that the Canadian Gross Domestic Product (GDP) and oil prices significantly affect the revenues generated through fee-based activities. We also find a high positive correlation between fee-based income and net interest income. Additionally, we find that trading activity generates the most volatile income stream and eventually increases the volatility of bank earnings.

We construct a Monte Carlo simulation model to analyze bank income under different possible economic scenarios. The Monte Carlo model simulates different types of banks that are common not only in Canada, but also around the world. In addition to net interest income, these hypothetical banks can generate three categories of fee-based income: traditional income, basic non-traditional income, and advanced non-traditional income. We also account for the costs associated with fee-based income in our analysis. Through simulations we find that a small change in the term structure of interest rates leads to insignificant changes in income at any type of bank, eliminating the need to hedge against interest rate risk. Moreover, even when interest rates are expected to move dramatically, banks have optimal balance sheet structures that minimize interest rate risk and optimize the volatility of income. Banks with sub-optimal balance sheet structures need to hedge in order to avoid financial distress. We find that hedging works equally well when a bank hedges its entire net income or just the net interest income component. Moreover, some sources of fee-based income can serve as a good hedging tool against the

interest rate risk because they provide a steady income stream that could serve as a cushion for earnings. For example, traditional income and basic non-traditional income decrease risk per unit of return and help banks to stabilize revenues. However, advanced non-traditional income increases earnings volatility and might even lead a bank to financial distress.

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CHAPTER 1: INTRODUCTION

Canadian banks have transformed profit-making techniques over the past decade. Usually the main portion of revenues in a bank came from the interest income, this is the income that is generated from the difference in interest gained on loans and paid on deposits. However, in recent years noninterest income became as important as interest income; and now the profits are equally dependent on these two sources. Noninterest income, or fee based income, refers to the earnings from different financial services, traditional and non-traditional. Banks have been offering traditional fee-based services for many years, but relatively recently have started to offer non-traditional fee-based services such as brokerage, investment banking, insurance, and securitization. The amendment to the Bank Act of 1987 in Canada was similar to the Gramm-Leach-Bliley Act in the United States and legally allowed banks to enter the securities and insurance business, ceasing the separation of financial institutions in Canada. Since then, large Canadian banks have been engaged in new services and have increased their dependence on fee-based income. We found that fee based income contributes to around 50% of net revenues and therefore, fee-based services play a significant role in Canadian banks. Rapid growth of non-interest income has raised many questions regarding the riskiness and efficiency of non-traditional income; and the overall change in the banking system has raised concerns about more complicated hedging strategies.

The previous financial literature on fee-based income presents conflicting results. Studies of the United States banks (DeYoung and Roland, 2001; Stiroh, 2004) suggest a high volatility of fee-based income and a high positive correlation between fee-based income and net interest income that brings no diversification opportunity for banks. On the other hand, European studies (ECB, 2000; Smith et al., 2003; Baele et al., 2007) and Australian studies (Williams and Prather, 2010) find a lower volatility of fee-based income and almost no or negative correlation between fee-based income and net interest income; international studies find some diversification benefit from engaging in nontraditional activities. Our research aims to resolve an existing conflict in the literature regarding fee-based income and present a case of a Canadian banking industry that is different from both the United States and European banking systems. For example, the United States and Canada have different branch banking arrangements (Freedman, 1998). In Canada,

banking arrangements are nation-wide, but in the United States they are region-based. The Canadian banking industry could be described as an oligopoly with only six large players in the market. On the other hand, the United States banking industry has several nation-wide banks and the rest are regional banks of different sizes. Hendrickson and Nichols (2001) identify six provisions that set the difference in operating environments for banks in the United States and Canada: capital-asset requirements, permissible investment activity, permissible loan activity, restrictions on deposit interest rates, branch banking rights, and deposit insurance. An example of provisions regarding investment activity in Canada is the change to the Bank Act in 1987 that allowed Canadian banks to enter the securities business. Almost at the same time, similar regulations were adopted for European banks. However, in the United States banks were given the power to enter securities or insurance business much later in 1999. The European Central Bank (2000) claims that European banks, being more experienced in managing fee-based income, are more efficient at diversifying risks. Still, Gart and Pierce (1998) discuss that European and United States banks have differences in goals and strategies, as well as management styles that impact their earnings.

In this paper we try to answer questions about the volatility of fee-based income and its impact on earnings volatility in Canadian banks. We conduct both empirical analysis of revenues and a Monte Carlo simulation to account for various possible economic scenarios. Through the empirical analysis we find a high positive correlation of fee-based income with net interest income in Canadian banks. We also find that two thirds of income in Canada is generated from non-traditional activities. Some of these activities are risky and generate a highly volatile income stream that negatively affects earnings. For example, during the financial downturn some Canadian banks reported losses from trading income. In 2007 CIBC reported a loss of six billion dollars from trading income that led to a two billion loss in net income. Moreover, we find that securitization activities also generate volatile revenues, but all other fee-based activities provide a relatively stable income stream to the bank. This stream is highly dependent on the consumer market. Rogers and Sinkey (1999) found that banks with a focus on customer relations have higher profits from fee-based income compared to banks with a different focus. In our paper we analyze sixteen macroeconomic variables that might affect the consumer market and impact the revenues from the noninterest activities. We find that Gross Domestic Product (GDP) and oil

prices show a significant impact on different fee-based income components in Canadian banks and could be used to predict the future income. Therefore, we use the observed relationship between fee-based income and these macroeconomic variables to model noninterest income in our Monte Carlo simulation model.

Monte Carlo simulation accounts for different types of banks that could be present in Canada and world-wide. We assume that there could be four types of banks. Bank Type I only generates net interest income and does not have any fee-based income component. Type II bank generates net interest income and traditional fee-based income. Type III bank, in addition to net interest income and traditional fee-based income, generates basic non-traditional fee-based income. And Type IV bank generates four types of income: net interest income, traditional fee-based income, basic non-traditional, and advanced non-traditional fee-based income. We simulate each type of bank over five year periods based on different interest rate environments. Modeling of the simulation also involves empirical analysis of the lending rate and Canadian term structure of interest rates. We find that historically, mortgage rates were linked to Treasury rates through a fixed premium that increases with maturity.

Results of the Monte Carlo simulation of different types of banks show that as long as there is no extreme movements in term structure of interest rates, all types of banks are safe from financial distress. And even if a dramatic change in interest rates occurs, all types of banks still have some structures of balance sheet where income would be little affected by any change in rates. These optimal compositions of balance sheets help a bank to avoid entering derivative contracts and hedge naturally. However, if a bank does not hold an optimal structure of the balance sheet it should hedge its revenues to avoid the financial distress. We investigate how banks can hedge their revenues against interest rate risk and simulate hedging through a Monte Carlo model by using Eurodollar futures. We find that although non-traditional fee-based income is considered to be quite volatile, it could be soundly hedged. Hedging works equally well for all types of banks independent of whether a bank hedges the entire total income or just the net interest income component. We also find that some sources of fee-based income can serve as a good hedging tool against the interest rate risk. Income generated through traditional and basic non-traditional activities generates a stable income stream that could serve as a cushion for bank earnings. Provision of advanced non-traditional fee-based services significantly increases risk,

but due to high volatility does not necessary increase the return of a bank. In our research we also consider costs associated with fee-based income and include them into our analysis. Fixed costs related to the generation of fee-based income magnify volatility of bank earnings and could be seen as an operating leverage because a bank commits fixed costs, or investments, in the beginning of operations, but future revenue or return on investments is uncertain.

Our study brings useful implications for bank managers and policymakers. Managers can use the findings of this paper to understand fee-based income and effectively manage and hedge interest rate risk. Moreover, bank managers can use our Monte Carlo simulation to forecast earnings in different economic scenarios. And policymakers can get more insight into Canadian banking that will help them to impose more sound regulations.

The paper is structured as follows. Firstly, we cover the financial literature to review the hedging against the interest rate risk, term structure of the interest rates, loan pricing, and the fee-based income. Then, in Chapter 3 we discuss our hypothesis and in Chapter 4 we discuss the methodology we will use to test them. In Chapter 5 we provide the empirical analysis for the sources of the fee-based income and their dependence on the macroeconomic factors, discuss the Canadian term structure of the interest rates, and the fixed rate loan risk premiums. In Chapter 6 we incorporate our empirical findings into the bank simulation model and present simulation results. And finally, in Chapter 7 we present conclusions and discussions.

CHAPTER 2: LITERATURE REVIEW

There are two sources of revenue in banks: net interest income and fee-based income. Net interest income is constantly facing interest rate risk that is associated with the unexpected and unfavorable move in the interest rates. The move in rates may negatively affect the price of the bank's assets and decrease the income generated by the bank. The fee-based income may either magnify or decrease this interest rate risk. Moreover, in order to minimize the exposure to the interest rate risk banks can either be actively involved in the asset-liability management or use financial derivatives for hedging.

2.1 Interest Rate Risk

Asset-liability management refers to matching the mix of the variable rate and fixed rate loans and deposits in the balance sheet. According to Flannery (1981, 1983), banks have different choices of assets and liabilities that can be combined into portfolios based on the same average maturity; and this strategy will be enough to hedge the net interest income against any moves in the interest rates. Ideally, the difference in risk sensitive assets and risk sensitive liabilities, or GAP, should be equal to zero; however, empirical research of Son Lai and Hassan (1997) shows that banks never have a zero funding GAP. It is very difficult to perfectly match all the assets and liabilities and usually banks do not have such flexibility. However, Son Lai and Hassan (1997) argue that most of the banks modify their structure of the balance sheet according to the anticipated change in rates, or in other words, actively participate in the management of the balance sheet. For example, in the rising interest rate environment, banks that have a large negative GAP would try to decrease it towards zero and banks with a positive GAP would try to increase the GAP. Still, such modification is mostly relevant to the one-year GAP or five-year GAP, and the last, according to empirical research of small US banks by Son Lai and Hassan (1997), generally constitutes 18-21% of the total assets. Banks are unlikely to modify the GAP of less than one year to benefit from the move in the interest rates. Short-term modification of the composition of the balance sheet is difficult to implement due to the lack of flexibility and the possibility of decreasing competitive advantage of the bank. For example, a bank with a large positive GAP expecting rates to decrease may choose to reduce GAP by decreasing rate-sensitive

assets or increasing rate-sensitive liabilities. That means a bank has to reject some of the clients who need a loan or attract clients who want to deposit some funds into the bank. By following this strategy the bank will lose its clients because they will take a loan from another bank. And the number of depositors is limited, making it hard to find new clients, unless the bank offers them good returns that in turn will decrease the net interest margin.

Stable net interest income under changing interest rate environment signals that the bank actively manages the balance sheet portfolio, and therefore, succeeds in natural hedging. Flannery (1981) estimates the average maturities of assets and liabilities in US banks and performs a regression analysis of the historical accounting data, from which he concludes that large banks hedge through the proper asset-liability management. In his later paper of 1983 Flannery proves that small US banks also follow the same strategy; and although banks experience some short-term fluctuations in the net interest income, there is no danger of high income variability in the long-run. Veit and Reiff (1983) conducted an empirical survey on banks' hedging policies and found that the majority of banks in the United States do not enter derivatives positions. Even in the modern banking environment that undergoes many dynamic changes the asset-liability management is still an important strategy to manage interest rate risk (Vij, 2003). Son Lai and Hassan (1997) find that small US banks are still effective in asset-liability management and use natural hedging to protect themselves against the interest rate risk. The authors develop a model that links the maturity gaps with the net interest margin of a bank and find a significant direct relationship between the two. The similar finding was reached by the later research of Brewer, Jackson, and Moser (2001), who found that small banks tend to avoid using financial derivatives. Moreover, according to Brewer et al. (2001) banks that do not use derivative instruments have higher interest rate margins. The above discussion signals that banks don't need any derivatives and can hedge naturally by active asset liability management. These findings lead us to the first hypothesis that banks can avoid financial distress without any derivatives.

In the case of the inability of a bank to match the balance sheet mix, a bank can hedge the resulted GAP through the money market or derivatives market (Brodt, 1988). Financial derivatives were not popular before the mid 80-s and most banks relied on asset liability management to manage the interest rate risk. However, Booth, Smith, and Stolz (1984) explain

the findings of the previous research by unfavorable restrictions in regulations and accounting policies of that time and by the absence of knowledge about the financial futures. And the authors suggest that banks should use derivatives to hedge particular loans. Development of various financial instruments led to different structure of the balance sheet, making the portfolio more risky than the traditional balance sheet and therefore, requiring more sophisticated hedging strategies. The empirical study of Brewer et al. (2001) of the US banks shows banks that have risky balance sheet profiles are more likely to use derivatives. Still, it is hard to tell whether the initial balance sheet structure forces a bank to use derivatives, or the decision to use derivatives allows a bank to have more risky profiles. Mahieu and Xu (2007) find that when the bank characteristics such as loan commitment, demand deposit, return on equity, size and credit spread are high a bank is more likely to use the financial derivatives for hedging. On the other hand, higher interest rate and term spread lead to less willingness to enter derivatives positions.

Derivatives allow banks to decrease the amount of expensive capital (Brewer et al., 2001). However, banks can use derivatives both for hedging and speculation reasons (Asay et al., 1981). Hedging refers to minimization of the interest rate risk. And speculation, on the other hand, refers to the higher interest rate risk due to the greed of bank to benefit from the interest rate moves. In order not to overhedge and avoid speculation, a bank should find the optimal hedge ratio that will minimize the number of derivatives contracts needed for successful hedging.

Drehmann, Sorensen, and Stringa (2006) discuss that interest rate risk is correlated with credit risk; as a result, an impact of interest rate risk on bank stability is higher than expected. Overlooking correlation of interest rate risk with credit risk might significantly underestimate the total risk. Baldan, Zen and Rebonato (2012) write that interest rate risk also impacts liquidity risk. Different time in repricing of assets and liabilities not only makes a bank exposed to interest rate risk, but also creates instability in the cash flow that leads to liquidity risk. For example, if most of assets in the balance sheet of a bank are long-term, but liabilities are short-term there could be a large negative funding GAP. The negative GAP makes a bank dramatically exposed to risk of rise in interest rates. Moreover, the large negative GAP could show a high exposure to liquidity risk; in the case of massive deposit withdrawals a bank could be unable to meet its obligations to depositors. Therefore, overlooking correlation between interest rate risk and liquidity risk may also significantly underestimate the total risk. Imbierowicz and Rauch (2012)

mention correlation between liquidity and credit risk; failure of a bank to collect payments on loans could negatively reflect on its ability to meet obligations to depositors. The authors suggest that these risks should be managed jointly in order to decrease a default risk in banks. Alessandri and Drehmann (2010) claim that interest rate risk, credit risk and liquidity risk amplify one another and result in a higher total risk for a bank.

2.1.1 Hedging Strategies

Kolb, Timme, and Gay (1984) develop a theoretical framework for micro and macro hedging strategies in commercial banking. Microhedging usually involves hedging a particular asset or liability against the interest rate risk. For example, a bank might issue a large long term fixed rate loan and short the futures to hedge this particular loan against the increase in the interest rates. The main benefit of the microhedging relative to the macrohedging, according to Kolb et al. (1984), is that it makes describing hedging in accounting easier and also satisfies open information requirements. And macrohedging refers to hedging of the entire balance sheet of the bank with the derivatives contract. The authors discuss the benefits and cost of micro and macro hedging under different conditions. They find that macrohedging outperforms microhedging under conditions of fully available information and transaction costs. Macrohedging allows a lower, and therefore, more efficient hedge ratio due to the natural offset of the cash flows from the assets and liabilities. Nevertheless, unavailability of the perfect information in the real world might restrict banks from implementing macrohedging. In the situation when a bank cannot implement the macrohedging, Kolb et al. (1984) instead suggest to implement the series of micro hedges. The later research of Goldfarb (1987), Koppenhaver (1985, 1990), Morgan et al.(1988), Tannous(1991), and Vindzanovic et al. (2011) confirmed the finding of Kolb et al.(1984) that in general macrohedging is a more effective strategy than microhedging in commercial banks.

Although it is clear that banks should follow a macrohedging strategy, there is a debate about the portion of the balance sheet that should be hedged. The first authors who discussed the optimal hedge ratio with the financial futures were Working (1953) and Johnson (1960). They developed a hedging framework that allows banks to minimize the variance of returns by maximizing the utility. Then based on the portfolio theory, Ederington (1979) and Francle (1980) developed a simple regression model that helps commercial banks to determine the optimal

hedge ratio that will minimize the variance of returns. Ederington (1979) suggests that the futures position should be used to hedge only part of the portfolio. Nevertheless, he does not identify the exact percentage of the portfolio that should be hedged. Goldfarb (1987) develops a two period macrohedging model that takes into account the asymmetric risks, such as a prepayment risk and a cap on a variable rate loan. He advises that the bank should hedge the entire position, but in the case of the prepayment risk the bank should increase the optimal hedge amount and purchase more futures (or sell fewer futures). And in the case of the cap on the variable rate loans the bank should decrease the hedge amount and purchase less futures (or sell more futures) in order to achieve optimal hedging. Brodt (1988) develops multi-period setting model that helps to determine the future balance sheet composition and the financial futures position which will minimize the bank operating risk. He uses Mean-MAD/ Financial Futures Model that is based on the Markowitz portfolio theory. In order to use the model, a bank has to know the current structure of the balance sheet and future investment opportunities, available funds, future revenues and expenses, and the future interest rates. Brodt finds that banks that use financial futures generate better risk-return trade-off in their profits than banks that do not use futures for hedging.

Koppenhaver (1985) develops a hedging model for a bank under different levels of risk aversion. His model takes into account the uncertainty regarding the quantity of deposits and uncertainty of the future rate on the Certificates of Deposits. Koppenhaver finds that if a bank is absolute risk averse and expects futures rates to increase then the optimal hedge amount should be lower than the hundred percent of the hedged portfolio. The author claims that the hedging based on the utility maximization strategy is more efficient than hedging based on the minimum variance of returns suggested by Kolb et al. (1984). Moreover, he finds that hedging with the Certificate of Deposits futures contracts is more effective than hedging with the Treasury bill futures contracts. The empirical work of Koppenhaver (1990) claims that the futures positions of banks depend on the size of the bank, experience with foreign currency forward markets, and the interest rate swaps. In his paper the futures position consists of two parts: expectation term and interest rate risk term. The author suggests that microhedging is only effective if the hedged balance sheet item is the main source of risk, but in general, macrohedging is a more effective hedging strategy. He claims that banks use microhedging to hedge the off balance sheet risks.

Morgan, Shome, and Smith (1988) extend the optimal hedging model developed by Koppenhaver (1985) and incorporate the uncertainty about the supply and demand of loans and deposits as well as the uncertainty about the future rate on loans and deposits. They find that the traditional hedge ratios discussed by the financial literature should be lower to achieve the optimal hedging in the financial institution. However, the authors assume that the market is perfect and there are no transaction costs, setup costs and information asymmetry. In reality, macrohedging will involve high transaction costs because it might require a large position in futures. And also in reality the set up costs are significant because macrohedging requires specific and restricted knowledge. Tannous (1991) improves the hedging model by incorporating the setup and transaction costs, as well as symmetric and asymmetric risks. The author defines the interest rate risk as the variance of the return on the net worth from a target return. He finds that financial futures reduce the interest rate risk for all banks independent of their size, especially when the model does not account for the set-up costs. And when the model considers the set-up cost, the most significant reduction of the interest rate risk happens in the medium-sized banks. Moreover, the author notes that the asymmetric risks increase the number of futures required to hedge against the interest rate risk. Even though the asymmetric risk requires a higher hedging ratio, it cannot be fully diversified. Interest rate cap risk and early prepayment of loan risk could be minimized by the bank, but the default risk is almost impossible to eliminate. Tannous (1991) compared micro versus macro hedging across different size banks and concluded that in general, macrohedging is more efficient than microhedging.

Although financial literature suggests that the optimal hedging ratio should involve a smaller volume of futures (Ederington, 1979; Morgan et al., 1988; Tannous, 1991), none of the studies suggest what portion of the funding GAP should be hedged. The hedging models developed after 2000s are mostly modifications of the existing techniques and include other risks in addition to the interest rate risk. Drehmann et al. (2006) evaluates the impact of the interest rate risk and credit risk on the value and the future profits of bank. Vindzanovic, Momcilovic, and Begovic (2011) suggest that banks are better off if they hedge against all risks simultaneously. In order to totally hedge against the interest rate risk, credit risk and currency risk, the bank would just determine the optimal amount of futures to buy and sell. The authors notice that the total macrohedge is not possible because it will hedge the bank against both

downside and upside risks, but the banks are willing to have exposure to upside risks in order to generate some profit. Nevertheless, the entire bank macrohedging is still possible when the bank hedges with options that will keep the exposure for upside risks open. However, their paper does not provide any empirical analysis that would support the claim that the macrohedging of all risks simultaneously is the most perfect form of hedging.

Bank loans are an important part of the interest rate risk, especially the long-term fixed rate loans. If a bank holds these loans in its portfolio and the interest rates rise, a bank is likely to experience the lower profit margin. In this case, the bank has two options to avoid the interest rate risk. Firstly, the bank can price the loans with the higher risk margin, creating a cushion for decreasing profit. However, due to tough competition the bank may not be able to increase the price of the loans. In this situation, the bank might use derivatives to hedge any potential drop in the profits. Brewer et al. (2001) suggests that when banks use derivatives for hedging the interest rate risk the loan portfolio grows faster. Banks do not artificially limit the number of loans in order to manage the asset-liability mix of the balance sheet; instead they meet the market loan needs by hedging the loan portfolio with financial derivatives.

2.2 Noninterest Income

Revenues in banks are also generated through fee-based activities. Fee-based activities do not involve any interest rates and just collect the fees for different financial services. Banks can charge customers deposit account fees, transaction fees, card fees, deposit box fees and other fiduciary service charges. Financial institutions have been charging those fees for many years and DeYoung and Rice (2004) classify them as traditional fees. A few decades ago, banks started to offer new services to their customers such as insurance, brokerage, investment banking and securitization. According to DeYoung and Rice (2004), these services are classified as non-traditional because they are relatively new. However, financial literature presents even more detailed classifications of the fee-based activities. DeYoung and Rice (2004b) separate the fee-based income into three groups: service charges, fiduciary income, and other income. Stiroh (2004) extends this division by adding the trading revenue class to it. Stiroh and Rumble (2006) use the same four categories of fee-based income as Stiroh. DeYoung and Torna (2013) provide

a different division of fee-based services based on three categories: stakeholder activities, fee-for-service activities, and traditional fee activities. Stakeholder activities involve holding risky assets and generate income from investment banking, trading and venture capital. Fee-for-service activities do not involve holding any risky assets and generate income through securities brokerage and insurance fees. Traditional fee activities are deposit and fiduciary services.

Fee-based income contributes different percentages towards bank total revenues in different countries. In Australia noninterest income accounts for only 20 percent of bank income (Williams and Prather, 2010), and in Europe 41% (ECB survey, 2000); whereas in the United States the portion of fee-based income is significantly higher, and on average fee-based income accounts for 44 percent of the bank revenue (DeYoung and Torna, 2013).

2.2.1 The United States studies

Non-traditional fee-based services were prohibited in the United States until the Gramm-Leach-Bliley act allowed financial institutions to enter securities and insurance business or consolidate with those firms. However, the rapid growth of noninterest income is not only attributed to the Gramm-Leach-Bliley Act, but also to the technological changes in the banking system. DeYoung and Rice (2004b) discuss that the developments in information and communication technologies, new intermediation technologies, and innovations in the financial markets have significantly increased the number of fee-based activities in U.S. banks. Banks are forced to provide a wide spectrum of different noninterest services to their customers in order to stay competitive in the market; and therefore, the revenues from fee-based activities are growing.

There is a direct relationship between the price and the level of non-traditional activities in banks. Rogers and Sinkey (1999) and DeYoung and Rice (2004 a, b) noticed that nontraditional services are provided only by the large banks. Rogers and Sinkey claim that the net interest margin in the large US banks is relatively small and the fee-based income serves as a stable source of revenue, reducing the risk of low earnings. Still, according to DeYoung and Rice, the main source of fee-based income is traditional payment services that contribute two thirds to the fee-based revenue.

Several papers discuss the volatility of fee-based income and its impact on the financial performance. DeYoung and Roland (2001) suggest that fee-based income is more volatile than

net interest income and therefore, makes the total revenues more volatile. Although noninterest income is associated with the higher premiums, banks face higher risk due to the larger leverage. Stiroh (2004) also finds that noninterest income is more volatile that net interest income. Later research of Stiroh (2006) is focusing on the relationship of non-interest income and bank stock returns. He finds larger involvement in fee-based activities makes stock returns more volatile and the overall risk-return trade off worsens. Nevertheless, the author points out that fiduciary income does not increase the risk, it is mostly raised by other non-interest income sources, especially trading activities. DeYoung and Rice (2004b) measure the financial performance of banks in terms of return on equity and find that noninterest income significantly increases the return on equity in banks. However, when the return on equity is adjusted for risk the noninterest income decreases this ratio in subsequent years. Therefore, the authors conclude that fee-based income has provided benefits for shareholders at the start; but after 1995 the return became not enough to offset the risks associated with fee-based income. DeJonghe (2010) finds that the stock price of banks that offer nontraditional services is more sensitive to the extreme macroeconomic activities, and as a result such banks are considered less stable than banks that specialize only in traditional services.

DeYoung and Torna (2013) analyze how nontraditional activities impact the probability of failure of the banks during the financial crisis. The authors find that in general, fee-based income helps banks to avoid the failure. However, once a bank is in financial distress, the stakeholder activities may accelerate the bank's failure. Empirical analysis shows that banks focusing on stakeholder activities also have a risky balance sheet profile with large amounts of debt and risky loans.

Although fee-based income is quite volatile, it might be negatively correlated to the net interest income and as a result, provide diversification benefit. Nevertheless, Stiroh (2004) finds a high positive correlation between net interest income and fee-based income in the US banks and suggests little opportunity for diversification. According to Stiroh, the service charges are highly correlated with the net interest income; and the reason is that the service revenue is generated through deposit account fees, check and transaction fees, or in other words, intermediation activities of the bank. Trading income has the lowest correlation coefficient and is believed to be the main source of risk in banks. The upward trend in correlation of all sources of

fee-based income with net interest income signals less diversification opportunity as banks become more involved into fee-based services. Moreover, Stiroh claims the higher the share of noninterest income in the bank the lower is profitability per unit of risk. Stiroh and Rumble (2006) also look into financial holding companies' income diversification opportunities and come to the conclusion that the high volatility of fee-based income outweighs all advantages of diversification.

Some financial literature investigates particular fee-based activities and their impact on different risks. Gallo, Apilado, and Kolari (1996) find that mutual fund services increase profitability, slightly reduce unsystematic risk, and have no significant impact over systematic risk. Jiangli and Pritsker (2008) find that securitization activities increase bank profitability, reduce insolvency risk, but also increase leverage ratios. Lown (2000), Allen and Jagtiani (2000), Estrella (2001) analyzed mergers of banks and other financial services companies in order to understand how non-traditional activities might affect the earnings and risk in a bank. They all found that the merger of a bank with an insurance company will bring the most diversification benefit to the bank's earnings. On the contrary, Fields (2007) claims that mergers of banks with insurance companies do not impact banks' market risk. And according to Allen and Jagtiani (2000), mergers of banks with securities firms even raise systematic and interest rate risks.

Through regression analysis, Rogers and Sinkey (1999) find a negative relationship between the size of nontraditional activities of a bank and its five year funding GAP, suggesting that banks with nontraditional activities are less exposed to the interest rate risk. The authors also find that noninterest income decreases liquidity and credit risk.

2.2.2 European and International Studies

European banks have experienced deregulation in the seventies and eighties, much earlier than their US peers, and have more experience in managing noninterest income. According to the European Central Bank survey (2000), the portion of fee-based income in operating revenue has been growing dramatically in the last years, from an average of 32% in 1995 to 41% in 1998. The share of fee-based income out of the total revenues varies from 33 to 55% for different EU countries. The European Central Bank noticed that although fee-based services increase both the revenues and costs, the profits are still higher with the noninterest income. Smith, Staikouras,

and Wood (2003) notice that fee-based income in European banks is more volatile than interest margin income. Nevertheless, ECB suggests that the volatility of noninterest income in European banks is still lower than in US banks.

Financial literature on European banks claims that fee-based services can make the banks safer and reduce the probability of default. Fee-based income serves as a good source of earnings diversification in the banking industry. Smith et al. (2003) find a very small and even negative correlation between fee-based and interest income for the majority of EU countries, suggesting a diversification opportunity. Moreover, the diversification benefit increases for smaller European Union countries. Similar results were found by Williams and Prather (2010) for Australian banks, where banks' fee-based income is highly volatile, but helps to diversify the risk. Fee-based income has a negative correlation with net interest income, providing diversification for the revenues. The authors claim that noninterest income improves the risk-return tradeoff in banks.

Laeven and Levine (2007) conduct an international study of financial institutions that spans 43 countries and covers the period of 1998-2002. They show that the financial market favors banks that specialize in a particular service rather than financial conglomerates. According to the authors, shareholders discount large financial conglomerates due to the high opportunities for insiders to expropriate wealth and the resulted agency problem. However, Baele, DeJonghe, and Vennet (2007) analyze the stock returns for European banks with fee-based activities and find that fee-based income increases the franchise value of a bank. Although the noninterest income might increase the systematic risk for a bank, it decreases idiosyncratic risk and reduces the probability of default.

The main source of risk in European banks is brokerage service (Lepetit et al.,2008). Lepetit et al. argues that trading activities that are found to be risky in the United States are not the source of risk for European banks; instead, trading activities reduce the asset and default risk for some banks.

The above literature review suggests contradicting results for different countries, therefore calling for research that would be specific for Canada. Most of the research done in the United States finds no diversification opportunity by the means of fee-based income; however European, Australian and other banks seem to benefit from nontraditional income.

Both the United States and international research agree that nontraditional services are usually associated with a higher systematic risk (DeJonghe, 2010; Allen and Jagtiani, 2000; Baele et al., 2007; Meier, 2010). This observation suggests that fee-based income is closely linked to some macroeconomic factors. And in order to test the relationship between fee-based income and macroeconomic factors we will need to perform a regression analysis.

2.2.3 Macroeconomic Factors

According to DeYoung and Rice (2004 a, b), fee-based income is correlated with the economy; therefore, one of the objectives of the study is to find macroeconomic variables that significantly impact sources of fee-based income in Canadian banks. In order to find the right macroeconomic variables, we consult the financial literature on the link between bank profitability and the economy. One of the most commonly used factors in the previous works is Gross Domestic Product (GDP). Economic development would stimulate demand for various services in banks, attract more funds and thus, increase the revenues. There should be a positive relationship between the Gross Domestic Product or Gross Domestic Product per capita, indexes of economic development, and bank profitability (Demirguc-Kunt and Huizinga (1999), Bikker and Hu(2002). GDP accounts for differences across banks and includes most of the possible omitted variables in the regression. Stiroh (2004) finds a link between the bank income growth and GDP growth. However, revenues from trading activities weaken this link, suggesting that trading has little dependence on current or previous GDP. Stiroh suggests that there is a higher correlation between fiduciary income, service charges and fees, and GDP.

Interest rates also play an important role in the profitability of banks. Literature shows different opinions about the impact of interest rates on profits. Hanweck and Kilcollin (1984) Samuelson (1945), Arpa (2001), Demirguc-Kunt and Huizinga (1999), Staikouras and Wood (2003) and Cheang (2005) found positive relationship between interest rates and bank profitability. However, Burgstaller (2006) did not find any significant correlation between bank profits and interest rates. In this paper we will analyze the effect of short-term, long-term, and real interest rates on the fee-based income. Athanasoglou, Brissimis, and Delis (2008) claim that in addition to economic development and interest rates, inflation is another one of the most common macroeconomic variables used to explain bank profits. Market capitalization is another

factor that may boost fee-based profits due to the high demand of underwriting and advisory services. Demirgüç-Kunt and Huizinga (1999, 2001), Bashir (2000) and Naceur (2003) in their work suggest that market capitalization may have a positive relationship with bank profits. In our paper we will employ all the discussed macroeconomic factors in our analysis.

2.3 Term Structure of Interest Rates

Interest rates are the basis of bank operations, and forecasting the future yield curve is of prime importance for the bank's simulation. The term structure of interest rates, or the yield curve, is formulated by scaling the current Treasury bond yields with their time to maturity. The yield curve can take several states: normal, flat, and inverted. Most of the time, we observe the normal yield curve that is asymptotically upward sloping and shows the yields for the long-term maturities higher than for the short-term maturities. The flat yield curve displays the similar rate level for the short-term and long-term securities. And the inverted yield curve occurs when the yields on government securities with long-term maturities are lower than the yields on short-term maturities.

There are several theories that explain the structure of the yield curve. The first is the expectations theory that claims the yield curve reflects the market expectations of the future interest rates. An upward sloping yield curve signals that the market expects the interest rates to rise, and a downward sloping yield curve signals that the market expects the interest rates to fall. The second is the arbitrage pricing theory that suggests the higher yields on securities with longer maturity compensate investors for expected inflation and rise in interest rates. For example, when investors believe that the economy will grow, they expect higher inflation. This higher inflation will force the central bank to increase the short-term interest rates with the goal to lower inflation. The third is the liquidity premium theory which asserts that investors will require the risk premium on the longer maturities bonds to compensate for the uncertainty in the change of the future interest rates. And the last is the preferred habit theory which insists that investors have different preferred investment horizons and demand for different maturities will impact the yield curve.

Moves in interest rates are hard to predict and the interest rate curve can take many different shapes. The financial literature developed many term structure models of the interest rates that aim to predicting the future structure of the yield curve. These models could be divided into arbitrage-free models and equilibrium models (Gibson, Lhabitant, and Talay, 2001). Arbitrage-free models assume that there is no arbitrage opportunity in the market and investors cannot reach a positive return without taking the risk. Therefore, these models make assumption about the price of risk and the behavior of the interest rates. Equilibrium models make an assumption that the economy tends toward equilibrium and the short-term rates have the mean-reversion feature. Short term rates incline towards the long-run economic equilibrium, and, based on their position above or below the equilibrium, have negative or positive drift. The equilibrium models usually use the utility function to create an endogenous model of the interest rates.

One of the most famous arbitrage-fee models is the model developed by Ho and Lee (1986). By taking the exogenous initial structure of the interest rates Ho and Lee (1986) create a binomial tree of the up and down movements in the interest rates. The authors base the model on the current bond prices and the discount rates and assume the parallel shift in the yield curve. According to the Ho-Lee model, the change in interest rate over the next period depends on the volatility of the interest rates and a time-dependant drift. And the up and down movements of rates are created through the assigned probabilities. The main weaknesses of this model are the generation of only upward sloping yield curve and the probability of negative interest rates. In order to overcome those weaknesses, Black, Derman, and Toy (1987, 1990) extend the model and introduce a mean-reverting concept along with the lognormal process that limits the rates to their positive values. Black and Karasinki (1991) further improve this model by introducing a continuous time function that allows the mean-reversion and the volatility of the interest rates to depend on time.

Vasicek (1977) presents a mean-reversion term structure of the interest rates model. The model implies that the effect of economic shocks on the short-term rates eventually disappears and the rates reach equilibrium. According to Vasicek, the change in interest rates depends on the volatility of the rates and the difference in equilibrium and the current rate. Moreover, the model incorporates the speed of mean reversion of the short term rates. The rates that are above the equilibrium will have a negative drift; and the rates that are below equilibrium will have a

positive drift. According to the model, the drift combines the risk premium and the interest rate expectations but the market does not distinguish between the two. The main advantage of the Vasicek model is that it lowers the volatility for the long-term rates, and thus, allows non-parallel shift of the yield curve. However, one of the main weaknesses of the model is the possibility of generating negative interest rates. Another weakness of the Vasicek model is the assumption that the volatility is independent from the level of the interest rates. The real economy reveals that the level of the interest rates significantly impacts the level of volatility. For example, in the high short-term rates and high inflation environment the volatility of the interest rates is high. And in the extremely low interest rate environment the volatility is limited to the level when the interest rates become negative.

In order to limit the generation of interest rates only to the positive values Cox, Ingersoll, and Ross (1985b) create a lognormal equilibrium term structure model. And in order to control for the changing volatility, the authors link the volatility to the level of the short-term interest rates. They claim that the higher short-term rates should have larger volatility. Nevertheless, the shortcoming of the Vasicek and Cox-Ingersoll-Ross models is that they imply an endogenous term structure and can hardly be fitted to the real yield curve. Hull and White (1990, 1994) extend those models by introducing time-varying functions for the model parameters.

The term structure of the interest rates could be also modeled through the yield curve fitting techniques. The future yield curve could be derived through the fitting of historical data of the interest rates. One of the most simple but ineffective techniques is a linear yield interpolation that matches the maturity with available bond yields. This technique is unable to produce smooth yield curves and the generated curves have unrealistic kinks. A more sophisticated technique is a piecewise cubic polynomial that joins several functional forms of the rates and generates a smoother yield curve. And probably the most popular and practical yield curve fitting technique is the Nelson-Siegel (1987) model. It is a multi-parameter model that can reflect monotonic, humped, and S shaped yield curve. Nelson and Siegel prove that their model explains 96% of the variation in the US Treasury bills during 1981-1983. Coroneo, Nyholm and Vidova-Koleva (2008) claim that central banks and public wealth managers are widely using the Nelson-Siegel term structure model. The authors test the model with the current US yield curve and find that the model fits the data well and satisfies the arbitrage-free condition.

Another term structure of interest rate was developed by Tannous (1991). According to Tannous, the change in interest rates in the next period should be equal to the spread multiplied by the slope of the yield curve variable. The slope variable consists of two components: the first one determines the magnitude of steepness of the yield curve and the second determines the upward or downward direction of the slope. The model also includes the random disturbance variable that is designed to reflect variations in interest rates. The Tannous model does not require extensive analysis of the historical rates and allows easy programming of the yield curve in the multi-period simulation settings.

According our best knowledge, the only study that empirically analyzed the term structure of interest rates in Canada was conducted by Bolder, Johnson and Metzler (2004). Bolder et al. find that different structural and macroeconomic changes in the Canadian bond market significantly affected the structure of the yield curve. They suggest that before 1997 the average yield curve had a significantly larger amount of dispersion around the mean than the post 1997 average yield curve. The analysis shows that the average yields decreased over time and the volatility of the yields for different maturities is lower in the post 1997 period. Moreover, the authors find that the yields do not follow the normal distribution.

Moneta claims that macroeconomic variables are priced into the Treasury yields. He finds that the information about inflation, employment, real activity, and business confidence significantly affects the bond returns. Moreover one single factor, such as labor market or business confidence, can explain the expected bond returns. The higher returns on the long-term bonds are explained through the higher exposure of long-term bonds to macroeconomic shocks.

2.4 Loan Pricing Theories

According to financial literature, financial institutions price their loans based on the markup to the benchmark rate. Koch (1995) presents the benchmark rate as a weighted marginal cost of funds, suggesting that the rates on loans depend on the borrowing cost and vary with this cost. On the other hand, Gottesman and Roberts (2004) use LIBOR as a benchmark rate by following the Loan Pricing Corporation that identifies the loan rate as “the basis point coupon spread over LIBOR plus the annual fee and upfront fee spread over the life of the loan”. The

empirical analysis conducted by Booth and Chua (1995) shows that the majority of US banks set the prime rate as a benchmark and link their loan spreads to this rate. However, the authors also describe that banks could add the spread to the Certificate of Deposit rate, Treasury bill rate, the commercial paper rate, the federal funds rate, a cost of funds index, and an index of money market rates. Large loans can be also linked to the multiple indexes; and the most popular combination of indexes is the prime rate and LIBOR. Norden and Wagner (2008) suggest that credit default swaps should also be incorporated into the loan pricing because there is a significant relationship between the two. Credit default swaps reflect the opportunity cost for taking new risks and could serve as a new loan pricing benchmark.

Hannan(1991) develops a banking model and prices loans as sum of the government security rate and a cost differential from administering loans and buying a security. The loan pricing model is also adjusted for the elasticity of the loan demand. Hannan (1991) finds that the rates on loans will be higher in banks that have higher market share and are operating in the concentrated market.

A pricing markup is added to the benchmark rate to minimize the risks related to the information asymmetry and to reward the bank for taking those risks (Gottesman and Roberts, 2004). Banks do not have access to all current and future information about the interest rates and the borrower's ability to pay back the loan; and in order to minimize their exposure to the risk banks may incorporate many factors to the loan price. Usually the determinants of the loan spread could be maturity and size of the loan, and the credit characteristics of the borrower such as the credit history and the presence of collateral. Booth and Chua (1995) also note that bank customers may incur some costs by switching bank and therefore, the bank is able to increase the loan rate until it is lower than the switching costs.

Maturity of the loan plays important part in formulating the contract rate. According to the trade-off hypothesis, bank loans follow an upward sloping term structure; and as a result, loans with longer time to maturity have higher markup. Helwege and Turner (1999) analyze the credit yield term structure for the bond issuers and empirically show that the yield curve is upward-sloping. Tannous (1991) suggests that the rate on loans could be modeled as the maturity premium over the cost of funds. This model will allow the bank to cover the borrowing costs and charge borrowers more for the long-term loans. Coleman et al. (2002) present the loan model as

the function of both lender and borrower characteristics, and the contract features. Borrower characteristics include the agency cost, taxation, credit quality and the variance of underlying assets. Bank characteristics include monitoring ability, bank risk, bargaining power and bank size. The authors find that banks with high bargaining power tend to issue short-term loans, and banks with monitoring abilities tend to issue long-term bonds but with a higher yield spread. Gottesman and Roberts (2004) describe that borrowers prefer the long-term loans because they might face high costs for liquidation of the loan and therefore, these borrowers are willing to pay higher rate on the long-term loans. Banks have to charge higher rates on long-term loans because of the higher risk related to the information asymmetry, risk of asset substitution and underinvestment. As a result, the markup on the benchmark rate is increasing with maturity of the loan and this fact was empirically observed by the authors. However, the study of Harjoto, Mullineaux, and Ha-Chin (2006) shows banks not only charge lower interest rates for loans shorter than one year but also for the long-term loans. The authors suggest that there is a nonlinear relationship between the credit spreads and the maturity of the loan. Nevertheless, there is no study developing or observing the exact mathematical relationship between maturity and loan spread.

Another important component of the loan pricing is the credit risk that may arise from the inability of the borrower to pay the loan back. Research of conducted by Flannery (1986) suggests that borrowers can signal their credit quality by asking for a particular maturity of the loan. He supposes that bad credit quality firms will be more inclined to take a long-term debt. And as result, banks should charge higher rates for the long-term borrowers. Anonymous (1995) suggests that banks should provide the credit rating to the loans they are issuing, and price each loan according to this credit rating. However, he notes that the majority of banks does not include the credit risk component in their loans and charge borrowers the rate dependant only on the size and maturity of the loan. Banks avoid pricing loans based on the credit quality because they are afraid to lose customers who might blame the bank for discrimination or switch to another bank that offers lower interest rates.

Strahan (1999) also reports a positive relationship between the loan rate and the credit quality of the borrower. He notices that small and financially weak firms pay higher rates on loans. He also finds that small loans, secured loans, and short-term loans have higher rates. The

explanation of the negative relationship between the time to maturity and the rate of the loan is that only stable companies are able to borrow long-term and banks offer them lower interest rates. Through regression analysis, Bernhardsen and Larsen (2003) show a direct positive relationship between the loan rate and the bankruptcy risk. And Gottesman and Roberts (2004) insists that the bank can force risky borrowers to take short-term loans to minimize the bank's exposure to the credit risk. Harjoto et al. (2006) also model the credit spread through the borrower's credit characteristics and financial performance, time to maturity of the loan and the loan purpose. Panyagometh et al. (2013) discuss the performance pricing covenants that automatically adjust the loan spread based on the current financial performance of the borrower. The authors find that as the credit quality of the borrower improves the markup on the loans decreases.

Banks also have syndicated loans that allow multiple banks to issue large loans and share the risk. Ivashina (2005) finds that banks price the syndicated loans similar to the traditional loan pricing strategy; they add a fixed spread over a floating benchmark rate. For syndicated loans the determinant of spread are the existence of collateral and covenants, private or public status of the firm, and the financial performance of the borrower.

Booth and Chua (1995) claim that in addition to the spread over the benchmark rate banks may charge borrowers additional fees. One of these fees is the up-front fee that is charged at the initiation of the loan and depends on the size of the loan. The authors declare the average size of this fee to be 105 basis points. The second fee is the annual fee charged for the unused portion of the loan and on average constitutes 41 basis points. The third fee is the standard annual fee that is usually 16 basis points. The fourth fee is the contract cancellation fee that is charged if the borrower decides to terminate or repay the loan early. This fee is usually 53 basis points. And the fifth fee is the letter of credit fee that is on average 143 basis points of the contract. Banks may charge borrowers only one or few of these fees and the fees are directly related to the loan features and the credit quality of the borrower.

2.5 Deposit Pricing Theories

The rate on the bank deposit is usually linked to the government security's rate discounted by the cost of managing the deposit account (Hannan, 1991; Tannous, 1991; Neumark and Sharpe, 1992; Hutchison, 1995; Kiser, 2004). Hannan and Liang (1993) find that the government is the main influencer of interest rates in banks. However, higher market concentration allows larger banks to influence others' deposit pricing policy. The deposit pricing model developed by Hannan (1991) sets the rate on deposit accounts through the difference between the Treasury rate and the marginal operational cost. The deposit rate is also corrected for the deposit elasticity which is unique for every bank and depends on the bank's marketability. The authors note that the maturity of the Treasury security used for pricing deposits should correspond to the maturity of the deposit contract. And the marginal cost of managing deposits could be estimated through the wages of employees and the cost of rent. Tannous (1991) develops a simulation model where he also connects the deposit rate to the Treasury bill rate with the relevant maturity and subtracts any administrative discounts related to the depository account. However, he does not use the empirical data for estimating the administration cost and guesses the approximate discount.

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Both Hannan and Tannous assume the operational cost as a fixed spread between the Treasury rate and the deposit rate. However, Hutchison (1995) claims that this spread changes over time. When the interest rates are rising the spread also increases, and when the interest rates are falling the spread will fall as well. According to economic theory, when the interest rate increases people should save more funds, and as a result, the demand for deposits increases. This increase in demand causes higher deposit liquidity, giving the opportunity for banks to increase the spread without a fear of losing customers. Neumark and Sharpe (1992) explain this phenomenon through market concentration. Depending on the market concentration, deposits adjust to changes in the Treasury rates with a different speed. In a highly concentrated market, deposit rates are slowly reacting to the rise in the interest rates and are quickly reacting to the

drop in the interest rates. The findings of Neumark and Sharpe suggest that banks are more willing to decrease the deposit rates than to increase them. Hannan and Berger (1991) also find that in concentrated market environments the deposit rates are rigid and banks will try to avoid increasing the deposit rates when the Treasury rates increase.

The findings of Hannan and Berger (1991), Neumark and Sharpe (1992), and Hutchison (1995) are based on the study of the US banks and therefore, signal the asymmetry in the deposit rates in the Unites States. However, Schnolnick (1999) claims that the behavior of the administrative cost spread is different for every country. For example, the Canadian banking industry is described by the high concentration of its six largest banks and is different from the United States banking industry where there are many regional banks. Through the analysis of the deposit interest rates in Canada, Schnolnick finds no asymmetry in the response of the Canadian rates to the changes in the Treasury rates.

Other factors that may influence the rates on deposits are the bank's market share and the reserve requirement. The research of Hannan (1991) concludes that banks with a large market share pay their customers lower interest rates on their deposit accounts. And a high reserve requirement will force the bank to give lower rates to their customers. Hannan and Prager (2004) explain that large multinational banks are providing lower interest rates to depositors because they have access to other cheap sources of funds and do not feel the need to attract many depositors. Kiser (2004) confirms their finding and asserts that the access to and price of the large-scale funds impacts the price of retail deposits. Moreover, according to Kiser, deposit rates are also dependent on the demand in the loan market. And according to Hung-Gay and Leung (1993), deposit contracts could also be priced through the futures market due to the cointegration between the Eurodollar deposit rates and Eurodollar futures.

CHAPTER 3: HYPOTHESES

Before the invention of different financial derivatives, banks were using asset liability management as a natural hedging tool. The asset liability management involves matching the mix of variable and fixed rate loans and deposits to formulate a balance sheet mix that will have the minimum exposure to the interest rate risk. The financial literature suggests that as banks became involved in many non-traditional services the risks increases and the asset liability management is no longer sufficient for banks to be safe; and as a result, banks are forced to enter derivatives position in order to hedge against the interest rate risk. However, have banks lost their ability for natural hedging completely? There was a time in the history when banks were providing only traditional services, mostly loans and deposits, and those banks were able to succeed in hedging without using any financial instruments. We want to test whether traditional banks operating in the current interest rate environment would be able to succeed in natural hedging and avoid the financial distress by properly managing the assets and liabilities.

Hypothesis 1: In a bank engaged exclusively in traditional banking, natural hedging is sufficient to prevent the financial distress.

We define financial distress as a significant decrease in the net income. As a benchmark for the significant decrease we will use 5% decrease in one year. If the bank net income decreases by 5% in a particular year, the effect on the earnings per share is even more dramatic and investors are very likely to consider the bank to be in a financial distress.

Although, banks report the composition of the balance sheet in the audited annual reports, they do not report the percentages of the fixed versus variable rate assets and liabilities. Due to unavailability of this data, it is hard to empirically observe whether the asset-liability management actually helps banks to avoid the financial distress. Therefore, we will use a Monte Carlo simulation that closely reproduces the real operations of banks and therefore, allows formulating an inference to the real world situation. We will test the first hypothesis by running the Monte Carlo simulation of bank earnings under different interest rate scenarios. From the data generated through the simulation we will analyze how income changes with the change in the balance sheet mix and the term structure of interest rates.

We believe that if the bank properly matches the fixed and variable rate assets and liabilities in the balance sheet and also correctly prices the loan portfolio, it could easily avoid the financial distress without using any derivative instruments. However, if this is not the case, just a moderate position in the financial derivatives will be sufficient for a bank to avoid the financial distress. According to our observations, Canadian banks hold a great amount of derivatives. They claim that one portion of these derivatives is used for the hedging purposes and another portion is used for speculation. Still, banks do not officially report how much derivatives they use solely for hedging purposes. During the 2007 financial crisis we evidenced that some banks used financial services for speculation and due to the wrong prediction of the economy have incurred large losses. If the bank manages properly the asset-liability portfolio, and prices the loans with enough premiums, it should be relatively safe and can easily avoid the financial distress. However, under extreme conditions the natural hedging might not work and the bank will need to use financial derivatives. We will run the Monte Carlo simulations of net interest income of a bank under extreme economic conditions and will test how big should be position in the derivatives to offset income volatility.

Hypothesis 2: If the natural hedging is not sufficient to prevent financial distress in a bank engaged exclusively in traditional banking, just a moderate position in derivatives is sufficient for financial safety.

Modern banks do not only generate net interest income but also collect a large portion of revenues from fee-based services and activities. The rapid growth of fee-based income in the recent years has brought many discussions. The financial literature has not yet reached consensus on whether fee-based income provides diversification opportunity and makes earnings less volatile. We aim to analyze the effect of fee-based income on the bank earnings in Canadian context. According to the literature, some sources of the fee-based income are risky and lead to higher volatility in the net income. However we believe that although some fee-based activities generate the highly volatile income, some services generate stable income. We will empirically analyze the fee-based activities of six largest Canadian banks to identify which activities lead to a more volatile income and which activities contribute a constant income stream. Then we will test our hypotheses by a Monte Carlo simulation of different types of banks that provide different levels of the fee-based activities.

Hypothesis3: In a bank engaged in traditional and non-traditional banking, natural hedging is sufficient to prevent financial distress.

Hypothesis 4: Some sources of the fee-based income could be a substitute for hedging against the interest rate risk.

CHAPTER 4: METHODOLOGY

The methodology of our research is a Monte Carlo simulation. The Monte Carlo simulation allows simulating different scenarios under uncertainty conditions. The purpose of our simulation is to forecast bank revenues under different scenarios of interest rate environment, evaluate the need for hedging against the interest rate risk, and test our hypotheses. Based on empirical analysis of six largest Canadian banks we create a model of a hypothetical bank. This model contains the balance sheet and income statement of the hypothetical bank and simulates the earnings. Revenues in the bank are derived from two sources: interest income and noninterest income. Interest income is generated from the intermediation activities of a bank, and refers to the difference in interest gained on loans (assets) and paid on deposits (liabilities). And noninterest income refers to the earnings from different financial services. Firstly, we will discuss the simulation model of interest income and then proceed to the discussion of the techniques we use to simulate noninterest income.

4.1 Net Interest Income

Interest income in the bank is directly related to the term structure of interest rates. Therefore, we will firstly model the term structure of interest rates and link all balance sheet items to it. And net interest income will be calculated from the difference in the rates gained on assets and the rates paid on liabilities.

4.1.1 Term Structure of Interest Rates

The interest rates are the basis of the bank operations and forecasting the future yield curve is of the major importance for the bank simulation. The current term structure of interest rates determines the rates on the deposits and loans and as a result, predicts net interest income. The term structure of interest rates, or the yield curve, is formulated by scaling the current Treasury bond yields with the maturity of the bonds. According to the expectations theory, the resulted yield curve reflects the market expectations of the future interest rates. The upward sloping yield curve signals that the market expects interest rates to rise, and the downward sloping yield curve signals that the market expects interest rates to fall. The moves in interest

rates are hard to predict and the yield curve can take many different slopes. By using the Monte Carlo simulation for the future yield curve we account for the uncertainty so that interest rates share some random factors and reflect the real world conditions.

The model of the future term structure of interest rates in this study is based on the method developed by Tannous (1991). In this model, the term structure of interest rates is tied to the rates on Government securities with the remaining maturities ranging from 1 month to 5 years. For the future reference, these maturities are indexed by i=1, 2,..., 60. Interest rates are determined by the following model[1]:

$$R_{it+1} = R_{1t} + (R_{it} - R_{1t})*\alpha + \varepsilon \qquad (1)$$

As R_i is the rate at time T on the Canadian government benchmark bond with remaining maturity *i*, R_{it+1} is the rate on the security in the next period of time. R_{1t} is the rate on the government security at time T with remaining maturity of 1 month. The random value that determines the slope of the yield curve is α. It consists of the product of two random variables, α_1 and α_2. The first one determines the magnitude of steepness of the yield curve, makes it more or less steep. In our model, α_1 is a random number from a uniform distribution with a range of [0.80, 1.20]. This range is large enough to accommodate the monthly changes; still it could be easily changed to reflect the expected magnitude of steepness in the yield curve. Any value less than 1 will lead to the less steep yield curve, and any value more than 1 will make the curve steeper. And α_2 determines the sign of α. Generally, its value is 1, but in order to account for downward sloping curve α_2 can take value of -1. The last element in the model is ε, the random disturbance. It is designed to reflect variations in interest rates and is normally distributed with mean zero and positive variance. The yield curve is constructed under no arbitrage assumption.

[1] By using this model of term structure of interest rates we assume a regular change in the yield curve. However, we acknowledge that in the reality change in the yield curve may be not smooth and could have some irregularities.

The interest rates are stochastic and change every month; and every change in the term structure is reflected in the rates on assets and liabilities of the bank.

4.1.2 The Balance Sheet

The balance sheet reflects the position of a bank as at the date of the sheet. It consists of three sections: assets on the left side, liabilities and shareholders' equity on the right side. Assets usually consist of cash, funds held in other banks, Treasury securities, loans and fixed assets. Loans are usually separated into term and installment loans, and each type could be based on fixed or variable interest rates. These assets are called earning assets and they are the source of income for the bank, because the bank earns interest on loans, Treasury securities and some funds deposited in other institutions. The fixed assets are land, buildings, and equipment, as well as goodwill and derivatives. These fixed assets do not earn any interests.

The liabilities consist of chequing and savings accounts, overnight funds, term deposits, debt and other liabilities. Term deposits can be based on fixed or variable interest rates. These types of liabilities serve as a source of funds for a bank; however, a bank should pay interest in order to obtain those funds. For example, banks have to pay interest on saving accounts in order to attract customers to keep their money in that bank. Other liabilities may include derivatives, obligations related to securities sold short, obligations related to assets sold under repurchase agreements and securities loaned, insurance claims and policy benefits, and liabilities from discontinued operations. Usually these types of liabilities do not require any interest payments.

And finally, shareholders' equity consists of retained earnings and common shares. The right side of the balance sheet always equals to the left side of the balance sheet, and in other words, assets are the sum of liabilities with shareholders' equity.

The asset and liability classes, such as securities, loans, or deposits, have different maturities to meet the needs of different bank customers. In our bank model we assume that the largest maturity possible is five years. We assume that our hypothetical bank holds an equal amount of each maturity within the asset and liabilities classes. Furthermore, the proportions of the different asset classes stay the same during the simulation. In practice, however, banks hold less short-term assets and long-term assets so the largest weight is on securities with a medium maturity. The previous research of Tannous (1991) showed that putting different weights for

different maturities complicates the model, but does not change the results significantly; therefore, we assume equally weighted maturities.

In order to structure the typical balance sheet of a Canadian bank we looked into the average balance sheet of the six Canadian banks during the last three years: 2012, 2011 and 2010. Based on those observations we put weights on different classes of assets and liabilities in our model. The ordinal balance sheet for a hypothetical bank with detailed weights for each asset and liability class is presented in Table 1 (Appendix A, pg.86). We assume that the weights on both assets and liabilities will be stable over the year, and as an asset or liability matures, the new demand for it emerges. The dollar value of the balance sheet items will be changing with the dollar value of bank assets. Moreover, we assume that the demand for funds will satisfy any additional needs and liquidity.

In this research we are trying to simulate the normal operations of a bank. We simulate that customers bring deposits to the hypothetical bank and the bank uses those funds to issue loans, buy securities and fixed assets. The modeling for different asset and liabilities classes was developed by Tannous (1991). In this paper we make minor changes and apply those models in our simulation. We will start our discussion with modeling liabilities, or the source of funding for the bank.

4.1.2.1 Modeling liabilities

Banks have created different chequing, saving and investment accounts to accommodate their clients' needs. Chequing accounts in Canada are usually used for the general purposes and do not pay any interest. Our model reflects this fact and in our hypothetical bank we also do not pay any interest on the chequing accounts. Instead, the interest is paid on savings accounts. Savings accounts do not require any notice of withdrawal and convenient in use; but due to this convenience banks do not pay high rewards to the users of saving accounts. The rates on savings deposits are mostly variable and can change any time, and therefore, are calculated according to the following model:

$$SD_t = R_{1t} - AD + \varepsilon_{it} \qquad (2)$$

where R_1 is the rate on 1 month Treasury bill, AD is administrative discount and ε is the random disturbance. Savings deposits are repriced every month.

Fixed rate term deposits are savings accounts for a particular amount of time, or fixed term, and require notice of withdrawal. We assume that the rates on term deposits should be linked to Treasury rates minus any administrative costs associated with term deposit account. Therefore, the rates are set according to the following model:

$$TD_{it} = R_{it} - AD + \varepsilon_{it} \quad (3)$$

where i represents different maturities of the fixed rate term deposits, ranging from 1 month till 5 years, R is the rate on treasury securities, AD is the administrative discount, and ε is the random disturbance. Fixed rate term deposits offer the fixed rate on investment, so the rate does not change until maturity. We set the minimum on the rate for term deposits. Even when the interest rates decline, a bank still has to attract depositors and offer them a competitive rate. Rates on the variable rate term deposits are structured in the same way, except they change every month.

Sometimes a bank has to obtain funds through the overnight market, and therefore, has to pay interest to the overnight fund lenders. This interest is tied to the 1 month Treasury bill rate and varies every month.

$$OF_{it} = R_{1t} + \varepsilon_{it} \quad (4)$$

Another source of funds for the bank is debt. Debt is usually taken as the long-term financing option. In our model interest on the long term debt is attached to the five year Treasury bond rate and is fixed across five year time. At the end of five years interest rate on long term debt will be renegotiated.

$$D_{it} = R_{60t} + \varepsilon_{it} \quad (5)$$

Common stock and retained earnings are alternative sources of financing. We assume that our hypothetical bank has sold common shares in the beginning of operations and now neither sells nor buys any shares. Common stock is not receiving any interest; instead, all excess income in the retained earnings is paid out as dividends at the end of each month. Our model

assumes that common stock and retained earnings amounts as a percentage of assets are stable over time.

4.1.2.2 Modeling assets

The bank uses different sources of financing to generate assets. Assets include cash, securities, loans, and fixed assets. Groups of securities banks usually hold are state, municipal and corporate debt, mortgage-backed securities, asset-backed securities, and equities. Loans can be variable rate and fixed rate loans[2]. Examples of fixed rate and variable rate loans include mortgages, various personal, small business, and commercial loans. The interest on the fixed rate loans is generated through the following model:

$$FRTLit = R3t + RPit + \varepsilon it \qquad (6)$$

where i represents different maturities of the fixed rate term loans, ranging from 1 month till 5 years, R_3 is the yield of a 3-month Treasury bond, RP is a risk premium, and ε is a random disturbance. Fixed rate loans might be very beneficial for borrowers because of the stability and constant interest rates in the case of rising interest rates scenario. However, in this scenario fixed rates become dangerous for a bank because they will lock a bank with a relatively low interest income and rising costs of obtaining capital. It is hard to predict a direction of the interest rates, and therefore, banks tie the fixed interest rates to the Treasury rates and charge risk premium to offset uncertainty. The higher the volatility in the term structure of interest rates the higher should be a risk premium. According to our empirical analysis of the mortgage rates and Canadian yield curve, banks usually charge risk premium of 200 basis points. Nevertheless, uncertainty in the future interest rates increases with maturity of the loans and banks charge

[2] We realize that loans can be both term loans and installment loans; however, for simplicity reasons we only model term loans in our simulation model.

higher risk premiums for longer maturities. The risk premium is modeled according to the following formula:

$$RPi = Constant * \sqrt[p]{M} \quad (7)$$

where constant could be any positive value, M is the time to maturity of the loan, and p is the power. Usually long-term loans have higher premium than the short-term loans, and to account for that we multiply the constant premium by the maturity of the loan raised to the power 1/p. In our model risk premium includes the credit risk and the maturity risk.

The rates on variable rate loans are determined by the model:

$$VRL_{it} = R_{1t} + VP \quad (8)$$

where i represents different maturities of the variable rate loans, ranging from 1 month till 5 years, R_1 is the rate on the 1 month Treasury bill and VP is the premium on the variable loans.

Cash and long term physical asset will not earn interest in our model. Moreover, we do not set the limit on the cash balance in our model because there is no reserve requirement in Canada.

The income statement shows all revenues and costs of operating the business. The income statement includes all income generated from the interest charged on loans, and any interest received from holding Treasury securities and deposits in other banks. It also includes all costs associated with the interest payments on deposits, overnight funds and debt obligations. The difference in interest income and interest expense leads to net interest income.

4.1.2.3 Decision variables

While loans and deposits are mainly driven by customer demand, banks usually have some control over the assets and liabilities in the balance sheet. For example, rejecting a customer who wants to deposit money will affect growth and competitiveness of a bank. On the other hand, attracting new depositors can sometimes be very difficult. However, banks can control the amount of loans they give to borrowers and can decrease or increase the interest rates to influence the demand. By offering more or less favorable rate, banks can also influence the

maturity of the loans or deposits customers are willing to take, and the terms of the contract such as variable or fixed rate.

Therefore, we assume that a typical bank will have 60% of the assets as loans of all maturities and 60% of the liabilities as short term and long term deposits. Furthermore, we build our simulation model assuming that a bank has control over the structure of loans and deposits. Namely, we assume that on the assets side the bank has fixed rate loans and variable rate loans and can control the amount of each as a percentage of total loans. On the liabilities side of the balance sheet, we assume that deposits are either variable rate or fixed rate and include demand deposits and term deposits. Furthermore, the bank can control the mix between variable and fixed rate deposits.

Controlling the mix of fixed and variable rate loans and the mix of fixed and variable rate deposits is formulated by using one decision variable that represents fixed rate loans and another variable that determines fixed rate deposits. Each of these two variables takes a value between 0 and 100% and once set, the percentage of the variable rate component will be set at 100% minus the percentage of fixed rate component. For example, when the fixed rate loans are only 20% of the overall loans it means that the variable rate loans constitute the other 80% of the loans. Similarly, if fixed rate liabilities are 70% it means that variable rate deposits on the liabilities side make up the other 30%. For simplicity, we change the percentage of fixed rate loans and fixed rate deposits in steps of 10%. This procedure leaves us with 121 scenarios of the balance sheet. Table 2 in Appendix A (pg. 87) summarizes our descriptions of the control variables.

4.2 Fee-Based Income

The noninterest income of a bank is generated from the provision of various services. In order to model income from fee-based activities in the simulation, we empirically analyze this income and link it to the macroeconomic variables. Rogers and Sinkey (1999) were first to argue that non-traditional services in banks require economies of scale and therefore, small banks are not able to offer these services for their customers. DeYoung and Rice (2004 a, b) also noticed that non-traditional services, such as securitization and insurance, are often offered by larger size institutions. Banks need a steady demand for these services in order to pay for expensive

professionals. Therefore, the main focus of our analysis is on the six largest Canadian banks that can afford having non-traditional services. These banks are Royal Bank of Canada, Canadian Imperial Bank of Commerce, Bank of Montreal, Bank of Nova Scotia, Toronto-Dominion bank, and National Bank of Canada.

The financial literature suggests that there is a link between the macroeconomic factors and the activities that give rise to fee-based income. However, due to the absence of any extensive research about the effect of macroeconomic variables on the non-interest income sources, we develop our own list of economic variables that could potentially impact the magnitude of the fee-based income. Table 3 (see Appendix A, pg. 88) presents sixteen macroeconomic variables that we examined and their sources of data. Most of the macroeconomic variables were obtained from Statistics Canada, World Bank, and International Monetary Fund databases.

The macroeconomic variables presented in Table 3 (see Appendix A, pg. 88) are selected for the following reasons. First, we reviewed the literature and identified several macroeconomic variables that have already proven to have an impact on the general profitability of a bank. These variables include GDP, interest rates, inflation, and stock market capitalization. These variables or proxies that represent them are included in the list. Second, we add to the list other macroeconomic variables that, to our knowledge, have not been studied before, and we propose that they have impact on the volume and price of fee-based services. For example, one of the major sources of fee-based income is securities trading. The possible macroeconomic factors that can affect securities trading revenues are equity trading volume at the Toronto Stock Exchange and the returns on the S&P/TSX index. We add these two variables to the list. In addition, we propose that the profitability of banks depends on the performance of the Canadian economy which in turn is affected by commodity prices, the level of foreign investment in Canada, and the employment rate. Therefore, we add the price of oil, Foreign Direct Investment (FDI), Net Foreign Direct Investment (NetFDI), and the unemployment rate to the list of macroeconomic variables that affect fee-based revenues.

Overall, we identified 10 sources of fee-based income. As shown in Table 4 (see Appendix A, pg. 89), we divide the fee-based services between traditional services, basic non-traditional services, and advanced non-traditional services.

For each source, we use ordinary least square (OLS) analysis to determine which macroeconomic variables have the most impact on that source. The basic formula for this analysis is:

$$Source\ of\ fee\text{-}based\ income_{ik} = \alpha + \beta * Macroeconomic\ factor_j \qquad (9)$$

where i = 1,…,10 represents different sources of fee-based income, k = 1,…,6 represents six banks, and j = 1,…,16 represents different macroeconomic factors.

4.3 Simulation Process

The normal operations of a hypothetical Canadian bank are simulated using one month as a time step. Every month new customers are coming to the bank for the purpose of either putting their money in the bank or taking a loan. Every month our hypothetical bank offers competitive rates to our new customers as these rates reflect the changes in interest rates. Customers can choose from the different options of maturities and fixed or variable rates. Therefore, the rates on variable rate loans and deposits are adjusted on a monthly basis. In contrast, once a customer chooses a fixed rate, this customer has to pay the agreed upon rate until maturity. The money from the loans that mature is reinvested in new loans and the funds that come due are refinanced by issuing new deposits. We assume constant demand and supply of funds as long as the corresponding rates reflect current conditions.

The simulation process consists of four major steps as shown in the flowchart provided in Figure 1 (see Appendix B, pg. 191)

First, we obtain the historical data for five years ending with the beginning of the period we want to simulate. This warm up period is very important for our analysis. For example, if the bank has started to operate at least five years ago and at that time has issued its first 5-years fixed rate loan, the bank will still be collecting the interest payments on that particular loan today until the loan is fully paid off. In our simulation we account for the previous operations of the bank by taking the historical zero-coupon bond yields as the historical term structure of the interest rates. The historical assets and liabilities of our hypothetical bank are tied to the zero-coupon yields through the models discussed above. The historical interest rates are only important for the fixed rate assets and liabilities, because they maintain the fixed interest rate until the assets or liability

matures. On the other hand, variable rate assets and liabilities are priced every month and do not require any historical data.

Second, we identify the structure of the balance sheet in a bank in terms of the value of all assets and liabilities and the proportions of the fixed rate loans and fixed rate liabilities. We account for the historical asset growth rates and simulate the possible future asset growth.

Third, we predict the change in the interest rates over the period we want to simulate. Based on our confidence, we can set different volatility for the changes in the interest rates. The simulation is run on a monthly basis, so each month there is a random shift in the yield curve that leads to a change in the interest rates charged on assets and liabilities. The difference in interest received on assets and paid on deposits generates the net interest income. The setting of the interest margin is set as a default, but we could also modify it by adjusting such variables as administrative discount on deposits, premiums on the fixed rate loans, and premiums on the variable rate loans.

Fourth, we estimate fee-based net income. We make a forecast of the macroeconomic variables over the simulated period and we use this forecast to generate the expected fee-based income. We use the level of the expected fee-based income to estimate the fixed costs associated with providing fee-based income. We assume that the fixed costs of providing fee-based services are committed at the beginning of the planning horizon (Time 0) to be paid on a yearly basis at the beginning of each year before knowing the actual revenues from the fee-based services. Then, our simulations will generate random fee-based income for each of the next five years. Generally, the actual annual income from the fee-based services might be lower or higher than expected, but the cost will be fixed and linked only to the expected amount.

All the error terms in the simulation are generated randomly, allowing uncertainty in the model. Each simulation is run 100 iterations. Each iteration represents the real economic scenario. The result of income is presented as the average of these 100 iterations and therefore, represents the most likely outcome.

One of the major assumptions of our model is that there will be no defaults on loans and no prepayments. Similarly, we assume that there are no early withdrawals of deposits. This assumption has five reasons behind it. Firstly, the probability of prepayments or early withdrawals is low because of penalties. Penalty could be a fixed amount of funds or loss of

accumulated interest. Secondly, rates should increase significantly to justify prepayment or early withdrawal. Thirdly, accounting for these options will not change the results of this paper significantly. A bank will be exposed to prepayment risk but the risk is small. Fourthly, prepayment or early withdrawal actually benefits a bank because a bank will gain funds through the penalty. And finally, including these options will significantly complicate our simulation model.

4.4 Hedging

One of this study's objectives is to find whether hedging is desirable, and if yes what would be the magnitude of the position in derivative securities to minimize the bank's risk. Furthermore, we would like to know whether fee-based services reduce the need for hedging using the derivatives market.

We define a bank's risk as the fluctuations in net income over the planning horizon. The higher the fluctuations the higher is the risk and the higher will be the possibility of financial distress. In particular, we assume that at the beginning of the planning horizon a bank will provide to the market a forecast for its earnings over the following 5 years. If the actual earnings turn out to be significantly lower than expected (negative deviation from expected net income), shareholders will not be happy and we call that financial distress. Therefore, our hedging activities and plans are designed to reduce any deviations from net income.

The procedure that we use to set up our hedge positions can be described as follows. First, we run our simulations assuming that rates will be stable over the planning horizon. Essentially, we assume that rates will fluctuate but the trend is not rising or dropping. This process generates the expected net income under stable interest rates. We call such income as the neutral income. Second, we use our forecast of interest rates to determine whether we expected a rise or a drop in rates, the magnitude of the expected changes (the slope of the trend), and the uncertainty of the forecast. We use these parameters in the simulation model to generate a forecast-based net income over the planning horizon. Third, we calculate the deviations of the forecast-based income from the neutral income. Fourth, we plan our trading of derivatives contracts to neutralize these deviations. Specifically, when our analysis suggests a negative

deviation for a particular year we short futures if the deviation is a result of a rise in rates or we buy futures if the deviation is a result of a drop in rates. Therefore, our positions in futures aim at stabilizing the any changes in income. We use three month Eurodollar futures to hedge one year income. In the beginning of every year we long/short three month Eurodollar futures that mature at the end of the year.

4.5 Data

The empirical analysis discussed in this paper covers the period from January 1990 to December 2012. The act that deregulated the Canadian banking industry and opened the door for banks to generate fee-based income became effective in 1987. However, not all banks immediately started to offer non-traditional fee-based services. Thus, we start our analysis in 1990. Our data on fee-based services is obtained from the financial statements of the six largest Canadian banks: Royal Bank of Canada, Canadian Imperial Bank of Commerce, Bank of Montreal, Bank of Nova Scotia, Toronto-Dominion bank, and National Bank of Canada. In addition, we analyzed the financial statements of the Laurentian bank and Canadian Western Bank to estimate the costs of the advanced non-traditional fee-based income. Data from the financial statements of those banks are manually collected through the archived annual reports. The daily data of Canadian zero-coupon bond yields was obtained through the Bank of Canada Statistics. This database was developed by Bolder et. el.(2004). The historical rates on 1, 3, and 5 year mortgages were obtained through CANSIM (Statistics Canada).

CHAPTER 5: EMPIRICAL ANALYSIS

5.1 Fee-based Income

Following the deregulations of 1987, fee-based revenues in Canadian banks have been gradually rising and this process can be evidenced from Figure 2 (see Appendix B, pg.192). In the early 90s noninterest income was contributing approximately 30% towards net income; and as banks gained experience and became more involved in various services, noninterest income as proportion of total income increased steadily and reached well above 55% in 2000. Since then, fee-based income as a proportion of total income has been fluctuating with a big drop in 2008. This drop can be explained by the huge losses from trading income in major banks. For example, due to a significant loss in trading income CIBC had to report negative profits for that year. Table 5 (see Appendix A, pg. 90) suggests that if we divide our sample into two sub-periods, we see that a percentage contribution of noninterest income to net revenues has expanded from 38% during 1990-1999 time period to 51% in 2000-2011 time period. This means that fee-based services became more developed over time and currently banks rely on fee-based income as much as they rely on net interest income.

According to DeYoung and Rice (2004), noninterest income can be divided into revenues from traditional services and revenues from non-traditional services. We further divide non-traditional services into basic and advanced. Basic services could be found in most banks, however, advanced services require large size and very skilled professionals so only few banks can offer advanced services. The sources of fee-based income have been evolving over years and have contributed different proportions of money to revenue (see Table 5 in Appendix A, pg. 90).

Deposit and payment, lending, card, and foreign exchange are considered traditional services banks have always been providing for their customers. There are some fees associated with those services, such as administrative fees for opening and maintaining account, using a card or deposit box, processing cheques, transferring and exchanging money, and many other services. Percentage contribution of income from traditional services to net revenues decreased from 15% in 1990-1999 to 13% in 2000-2011. Deposit and payment services generate the largest

portion of the traditional fee-based income. Still, the percentage contribution of deposit and payment fees decreased from 7.1% in 1990-1999 to 6.6% in 2000-2011.

Non-traditional services refer to activities that are not related to generation of loans and deposits. Non-traditional activities can be basic and advanced. Basic non-traditional services are provided by most of the modern banks, such as brokerage, insurance, securitization, and mutual fund services. Advanced non-traditional services are trading, investment management, underwriting and advisory; these activities require significant economies of scale and are only offered in large banks. Relatively recently Canadian banks started to offer non-traditional services for their customers; however, some services have been the largest contributors to net revenues since 1990. Basic non-traditional services on average contributed 11% to net income during 1990-1999. However, this percentage increased to 19% during 2000s. The largest sources of funds from basic non-traditional services are securities commissions and brokerage fees. When a customer invests money in the financial markets and performs some trades, a bank charges him a fixed fee for every transaction and a customer is paying securities commissions and brokerage fees. For example, in 2011 18% of fee-based income was generated through securities commissions and brokerage fees in the Bank of Montreal. This percent of securities commissions and brokerage fees dropped from 28% in 1998, however, still remained as one of the main sources of revenue. In the National Bank of Canada securities commission and fees contribute less, still significant percent of revenues to the fee-based income, 12%. Other banks present the contribution percentage of 7%-9% of securities commission and brokerage fees towards the non-interest income. The starting revenues from the service were significantly higher in 1990s, suggesting that over time brokerage fees have decreased and also some banks shifted towards activities other than brokerage. On average, revenue from brokerage services was 7% of net income during 1990-2011.

Banks sell various insurance to their customers and generate income from insurance premiums. In 2011, insurance created 27% of earnings for fee-based services in the Royal Bank of Canada. For the TD the number was 13%. The share of insurance in other banks is significantly lower, only 4-6%. Still, the insurance revenue share was increasing over years. On average, a percent of insurance income as of net revenue was 1.2% during 1990-2011 and became 3.6% during 2000-2011.

Banks also can have established mutual funds and charge investor management and administration fees related to those funds. In addition, banks sell mutual fund shares and generate commission fees. Mutual fund revenues as a percentage of net income rose from 1.9% in 1990s to 5.3% in 2000s across banks.

Securitization activity relates to pooling different types of debt together and selling it as securities. The revenue generated through the sale of the pooled debt is reported as securitization revenue. On average, contribution towards net interest income of securitization revenues increased from 1.4% during 1990s to 3.4 during 2000s.

Advanced non-traditional income is generated through investment banking and trading revenues. This income decreased from 13% during 1990-1999 to 11% in 2000-2011. The largest contributor from this type of income is underwriting and advisory fees. Banks help organizations to raise equity and in return charge them underwriting and advisory fees. In 2011, underwriting revenue contributed 8-9% to fee-based income in major banks. The larger proportion is in NBC, 12%. And the smaller proportion is TD, only 4%. On average, revenue from underwriting and advisory services was 6.6% of net income during 1990-1999, but decreased to 4.6% during 2000-2011.

Through investment management banks charge corporate and institutional investors fees related to capital-rising, mergers and acquisitions, and asset management. Investment management can generate large income; however, costs in terms of investment banking specialists are also high. In 2011, investment management revenue created 12% of revenues in overall fee-based income for RBC. This share was almost the same high for 22 consecutive years. Investment management in CIBC is only 8% of the non-interest income, and the share was increasing from 1% over years. Significantly decreased the percentage of profits from the investment management activity in BMO: from 13% in 1993 to 7% in 2011. Bank of Nova Scotia has insignificant share of revenues coming from the investment management and custodial fees, only 2% of the fee-based income as of 2011. On average, investment management contribution to net income increased from 2.4% in 1990-2011 to 3.7% in 2000-2011.

Trading income is generated by the bid-ask profits on the trading of securities and also includes the realized gains or losses on securities held-for-trading. These securities could be mortgage-backed securities, asset-backed securities, government and corporate debt, and

equities. Trading income is highly variable and the percentage contribution of trading income to fee-based revenue changes randomly from year to year in all banks. After some banks experienced losses in the trading revenue in 2007, the share of profits from this source significantly decreased in all banks. Probably banks became more cautious and now choose a more conservative risk strategy, or maybe simply the interest rate spreads on securities are very low now. As can be seen from the summary statistics, the trading income is highly volatile and may lead to a loss in the non-interest income and even net income. For instance, just from trading activity alone CIBC lost more than 6 billion dollars in 2007 that led to a 2 billion loss in the net income. We find trading to be the most risky activity that can even lead a bank to bankruptcy. Our findings are consistent with previous findings of Stiroh (2004) that the income from trading activities is extremely risky.

On the income statement banks also report realized gains or losses on available-for-sale and held-to-maturity securities they hold in their assets. These gains or losses are separate from the trading income. We provide descriptive statistics on the realized gains and losses but we do not include this income as part of fee-based income. Furthermore, banks report other income that includes combination of fees generated through other different services. These revenues are not significant (small) or recurring. Thus, banks report these revenues as other income.

DeYoung and Rice (2004) suggests that banks still generate the largest portion of the non-interest revenues from traditional activities such as payment services. However, our study reveals that the largest portion of the fee-generated income is coming from non-traditional services; they contribute almost twice as much as traditional services. This observation can be easily seen in Figure 3 (see Appendix B, pg.193). During 1990-1999 nontraditional services generated 61% of fee-based income; and this percentage increased to 64% during 2000-2011.

The summary statistics for fee-based income components is presented in Table 6 (see Appendix A, pg.91). The table shows that trading has the highest standard deviation followed by insurance. Somehow surprising is the income from mutual funds which has the third highest standard deviation. Trading is the only source of fee-based income that generated negative revenues. However, the numbers the revenues presented do not account for the direct costs of providing the corresponding services.

5.1.1 Correlations and diversification opportunity

One of our objectives is to determine whether fee-based services provide diversification in the income of banks. According to the portfolio theory, as long as there is no perfect correlation between fee-based income and net interest income, there is an opportunity for diversification. Table 7 (see Appendix A, pg.92) reports the correlations between net interest income and the revenue from each fee-based service. The three traditional fee-based incomes have the highest correlations with net interest income. The correlation coefficients range from 0.91 to 0.97. We also observe high correlations between net interest income and some nontraditional fee-based incomes. The correlations between net interest income and insurance, mutual funds, securitization, and investment management and securitization incomes are respectively 0.91, 0.91, 0.95, and 0.91. In contrast, the correlations between net interest income and underwriting revenue (0.59) and brokerage fees (0.55) are lower but still high. However, trading income and gains from available-for-sale securities have a negative correlation with net interest income (-0.04 and -0.24 respectively). Therefore, the fluctuations in net interest income may be slightly diversified by underwriting revenue, brokerage fees, and trading activities.

We investigate further the diversification effects by calculating the correlation coefficients between net interest income and the total fee-based income generated by each of the six largest Canadian banks. The results are presented in Table 8 (see Appendix A, pg.93). On average, fee-based income is highly correlated with net interest income for all banks but it is highest (correlation coefficient is above 0.90) for Bank of Montreal, Royal Bank of Canada, and Scotia Bank. The lowest correlation is for Canadian Imperial Bank of Commerce (CIBC). CIBC reported a loss in fee-based income in 2008 due to the huge loss in trading revenue and that might have driven the correlation results for CIBC. The third column of Table 8 (see Appendix A, pg.93) reports the correlations when we subtract trading revenues from the fee-based income. We observe that excluding trading revenues significantly increases the correlation for CIBC but only slightly changes it for other banks. Overall, the correlations seem to suggest that the diversification effects are small.

The aggregate total of fee-based income is essentially a pool of the different kinds of revenues. An interesting question is whether the revenues from various components of fee-based

services are highly correlated. This question is particularly important for banks that do not have the resources to provide all the services simultaneously. The correlations among the various fee-based income sources are presented in Table 9 (see Appendix A, pg.94). The table shows that most of the fee-based income sources are highly correlated with each other. However, there is no perfect correlation among them and this fact allows for some possibility of diversification within the fee-based income. On average, securities commission revenue is highly correlated with investment management, underwriting, and lending revenues; however, it is negatively correlated to the securitization revenue. The deposits and payment service income is highly positively correlated with other sources of the fee-based income, except for trading and securities gains or losses. Insurance revenue is highly positively correlated with securitization revenue, card services, and deposit, credit, and foreign exchange revenues. It is negatively correlated only with securities gains or losses. Investment management and custodial revenue is highly positively correlated with almost all sources of the fee-based income; the negative correlation presents only with securities gains or losses. Underwriting and advisory services revenue is highly positively correlated with all other non-interest income sources. We can distinguish three sources of the fee-based income that are the least correlated with other sources, and therefore, might provide diversification benefit. The revenues from trading, securitization, and securities gains or losses are highly volatile and do not follow the same pattern of income generation as other sources. The correlation between trading and other activities of the bank is very small and sometimes even negative, suggesting that there might be some diversification opportunity if a bank is involved in trading and any other activities. Securitization revenues also have low correlation coefficient with underwriting activities and negative correlation with the revenues from securities commissions and brokerage fees. Moreover, securities gains or losses share very low or negative correlations with all other sources of the fee-based income.

5.1.2 Fee-based Income and Macroeconomic factors

In order to build our simulation model to predict bank net income, we need models to predict fee-based income at banks. One possible solution to this issue is to use past observations of fee-based income and extrapolate this income into the future. Another approach is to find a set of macroeconomic factors that affect the economy in general and the revenues of banks and then

use these factors to forecast fee-based income. We prefer this approach as opposed to predicting fee-based income directly because the macroeconomic variables that we are proposing are well known to affect the economic activities in general, and significant resources are devoted to predict them. As a result, they are readily available for use by banks. The only missing tool to operationalize this approach is to find relationships between the various fee-based income and macroeconomic variables. This analysis will allow us to build forecasting models that will generate the fee-based income in a bank given the forecast of the macroeconomic variables.

We start with sixteen macroeconomic variables that we propose to explain the generation of fee-based income at banks. These variables and the summary statistics related to each one of them are presented in Table 10(see Appendix A, pg.95).

Table 11 (see Appendix A, pg.96) reports the correlations of the fee-based revenues with the macroeconomic variables. The table shows that securities commissions and brokerage fees are highly correlated with GDP per capita, GDP, and exports. However these fees are negatively correlated with the interest rates, inflation, and the unemployment rate. Deposit and service fees are positively correlated to such macroeconomic factors as GDP, market capitalization, foreign direct investments, equity trading volume, prices of oil and CPI. Deposits and payment service income is negatively correlated with the interest rates, insurance, and unemployment. Trading income is correlated only with Toronto Stock Exchange return, but the correlation coefficient is not high. Insurance revenues are positively correlated with most of the macroeconomic factors used in this study, except for inflation, unemployment, and interest rates. Investment management and custodial revenues are also highly positively correlated with most of the macroeconomic variables used in our study. However, we find negative correlation with TSX returns, unemployment, inflation, and interest rates. Underwriting and advisory services revenues have the highest correlation coefficients with GDP per capita, market capitalization, exports, and CPI. Securitization revenues have the highest correlation with GPD, FDI, Equity returns and CPI. Revenues generated through the mutual fund fees are highly positively correlated to all macroeconomic variables, except for interest rates, TSX return, and unemployment rate. A similar situation can be observed for lending, card, foreign exchange, and other revenues. Securities gains or losses have a random nature and have low or negative correlation coefficients

with all sixteen macroeconomic variables. The correlation coefficients give us insight about the relationship of the fee-based income sources with macroeconomic variables.

We want to investigate an impact of fee-based income on interest rate risk of a bank. Therefore, correlation of fee-based income sources with interest rates is a very important factor in our analysis. In general, we find a highly negative correlation between fee-based income and interest rates; but in order to make a more thorough analysis we divide our sample into two sub-samples, before and after 2000 and present results in Table 12 (see Appendix A, pg.97). Even after breaking our sample we find a negative correlation of fee-based income with interest rates during two time periods. Exception is securitization revenue that shows a high positive correlation with short-term interest rates before 2000 and revenues from securities commissions, trading and securities gains that show a positive correlation with both short-term and long-term interest rates after 2000.

Nevertheless, in order to model the fee-based income in the Monte-Carlo simulation we need more specific models that will predict the level of fee-based income based on the forecast of the macroeconomic conditions. We use ordinary least squares analysis to obtain models.

In the beginning of 1990s not all six banks immediately became engaged in non-traditional services. Some banks started to offer those services as early as 1990 while other banks did not start until 2000 or after. The difference in the starting date and in the volume of the fee-based income in six largest Canadian banks makes the general analysis quite hard. As a solution to this problem, we analyze separately for each bank the impact of each macroeconomic factor on each source of the fee-based income. As we identified 10 different types of fee-based services and 16 different macroeconomic variables, we conducted 160 regressions (10 x 16) for each bank. As we have six banks, we needed a total of 960 regressions (6 x 160). Then we calculate the average coefficients and other statistics across the six banks. Table 13-Table 22 in Appendix A (pg. 98-107) present the average mean and standard deviation of the regression across six banks. Each table reports the statistics for a single fee-based income.

The tables show that income from traditional services is closely linked to the economic activity in Canada and the regression analysis of the six largest Canadian banks suggests that GDP is one of the most appropriate macroeconomic factors that can explain income generated through traditional services. We observe a positive relationship between traditional fee-based

income sources and GDP. As GDP is a measure of the economic activities in a nation, it seems that as the economic activities grow people will use more banking services. Customers seem to increase their savings and deposit activities, open new accounts, make international and local payments and other transactions.

We find that GDP is the most significant explanatory variable also for most of non-traditional income sources. In particular, GDP seems to be the most significant variable in explaining the variations in income from brokerage, insurance, investment management, and mutual funds as GDP regressions provide the highest adjusted R-squared. The only exception is underwriting and advisory income which seems to be more positively affected by the price of oil although GDP remains a significant explanatory variable. As the oil price increases, underwriting activities seem to increase and Canadian banks normally benefit from these activities. Another factor that seems to explain significant variations in underwriting and advisory income is market capitalization. Perhaps, the increase in market capitalization prompts companies to issue new shares and that leads to significant underwriting activities and higher fee income for banks.

The finding that GDP is the most significant factor in explaining the variations in fee-based income from various sources is not surprising. As a country becomes more economically developed, people may accumulate more wealth and have more funds to invest in different financial assets. As a result, revenues from brokerage, investment management and mutual funds would increase. Merger and acquisition activity may increase in times of prosperous economy and revenues generated through investment management will grow. Moreover, economic growth may lead the public to buy more life insurance for individuals, businesses, and family members.

Income generated through trading seems to be unrelated to macroeconomic factors. Regression of this source of income on various macroeconomic variables did not produce any significant results (see Table 15 in Appendix A, pg. 100). Some banks show significant relationship of trading income with few macroeconomic variables, but this relationship is not consistent across banks. Therefore, in the simulation analysis we model trading according to the following model:

$$\text{Revenue} = \text{Mean for the last 5 years} + \varepsilon$$

where ε is a random error with mean zero and standard deviation of the income for the last five years.

Although individual regression results for every bank and every fee-based income source are informative, it is hard to combine them into a model that will generalize the process of generating fee-based income. The main objective of those regressions is to choose the macroeconomic variables that have the highest explanatory power and lead to significant regression results. Based on the individual regressions we choose three macroeconomic factors, GDP, lagged GDP, and oil price, and run regressions on the aggregate data of fee-based income. We add the data across banks and include only those banks that have been generating various fee-based revenues for a significant amount of time. Banks that did not generate particular income in earlier years may bias our results and therefore, we exclude them from our analysis. The panel data becomes limited to the dates and banks discussed in Table 23 (see Appendix A, pg.108).

Table 24 (see Appendix A, pg.109) reports the results of the regressions related to the aggregate fee-based income. GDP seems to explain the variations for most of the fee-based revenues including traditional and basic non-traditional fee-based services. Lagged GDP is a good macroeconomic variable to explain the variations in securitization revenues while the price of oil is the best predictor of underwriting and advisory fees. Of course, there are other factor that may be combined with GDP, lagged GDP, and oil price to improve the fit of the models but we decided to limit the number of the explanatory variables to one to avoid problems of multicollinearity and to keep the Monte-Carlo simulation model simple and tractable.

5.1.3 Cost of providing fee-based income

Rogers and Sinkey (1999) and DeYoung and Rice (2004 a, b) argue that some fee-based services require economies of scale and that fee-based income is associated with high costs. We accept their arguments and one of our objectives is to examine whether the fixed costs of providing fee-based services increase the volatility of bank net income.

In order to estimate the cost related to non-traditional bank activities we compare noninterest expenses in Canadian banks that provide those activities with the noninterest

expenses reported by Canadian banks that do not provide nontraditional activities. We only could find two Canadian banks that do not provide nontraditional activities on the same scale as the big six banks. Namely, the Laurentian bank and the Canadian Western Bank are the only two Canadian banks that provide the same services as the big six except of trading, underwriting and advisory services, and investment management. Although the income from all other services in the Laurentian bank and the Canadian Western Bank is relatively small, the low scale signals lower operational volume rather than the lack of expertise.

We use the following procedure to estimate the costs of the advanced nontraditional fee-based income. First, we calculate the noninterest expenses at the Laurentian bank and the Canadian Western Bank as percentages of total loans at the two banks. Then, we calculate the average ratio across the two banks. Similarly, we calculate the same ratio (noninterest expenses to total loans) for each of the big six banks and we take the average ratio for this group. We assume that the difference in the ratios of the two groups is attributable to the additional costs paid by the big six banks on average to provide the fee-based services of trading, underwriting and advisory services, and investment management.

Therefore, the costs of providing the extra fee-based services should be equal to the difference between the total noninterest expenses for each of the six largest Canadian banks and the total noninterest expenses for the banks if they were to provide only services that the Laurentian bank and the Canadian Western Bank are providing. The average extra cost across all banks is $3.338 billion and the average income from trading, underwriting and advisory services and investment management for the last 3 years across all banks is $7.829 billion. Therefore, we estimate that on average it costs 43 cents to generate $1 of the income from the three nontraditional services.

5.2 Canadian Term Structure of Interest Rates

In order to build our Monte Carlo simulation we analyze the historical data of the Canadian zero-coupon bonds. Our analysis covers bond maturities ranging from 3 month to 30 years. The summary statistics of the daily series from 1990 to 2012 is presented in Table 25 (see Appendix A, pg.110).

Using the data on Canadian zero-coupon bonds we construct the Canadian yield curve by plotting the rate on bond against the time to its maturity. The yield curve can have three shapes: normal, flat, and inverted. The yield curve is called normal when it is upward sloping which means that the yield on long term maturities is higher than the yield on short term maturities and as maturity increases the yield increases. A flat yield curve means that the yields on government securities with long-term maturities are almost the same as yields for the short-term maturities. An inverted yield curve occurs when the yields on government securities with long-term maturities are lower than the yields on short-term maturities and as maturity increases the yield decreases. The expectations and the risk premium theories are usually proposed to explain these shapes. According to the expectations theory, the higher yields on securities with longer maturity compensate investors for expected inflation and the expected rise in interest rates. For example, when investors believe that the economy will grow, they expect higher inflation, and higher inflation will force the central bank to increase the short-term interest rates with the aim to lower inflation. The expectation of higher future rates will lead investors to demand high rates for long term maturities and that leads to an upward sloping yield curve. In contrast, the risk premium theory suggests that there is a risk premium on the longer maturities to compensate investors for the uncertainty in the changes of future interest rates. The longer the maturity the larger is the liquidity premium. Therefore, the yield curve is upward sloping under normal conditions and in the absence of strong expectations of lower rates. The downward sloping yield curve only happens when investors expect significant recession in the economy and a decline in the future rate of inflation.

From the summary statistics in Table 25 (see Appendix A, pg.110) we can observe that during the 1990-2012 time period the short term interest rates were on average lower than the long term interest rates, signaling that on average the Canadian yield curve was normal. Further analysis of the data (not included for brevity) suggests that the Canadian yield curve was inverted during the late 1980s and during 1990. It remained inverted during January 1991 and the beginning of February of 1991. Other observations of an inverted yield curve happened in August 2000, September, October, November, and December of 2006, and the beginning of 2007. After 1990, the yield curve did not stay inverted for a whole year at a time. Figure 4 (see

Appendix B, pg.194) shows the average yield curves that were experienced from 2000 to 2012 inclusive.

We also analyze the possible annual shifts and moves in the Canadian yield curve. For this reason we find the first difference of the annual data. The summary statistics on the difference are presented in Table 26 (see Appendix A, pg.111). We notice that on average the change in the short-term interest rates is higher than in the long-term interest rates. This happens probably due to the overreaction of the market on the current events. The maximum increase in the annual interest rates in Canada was experienced during the 1990-2012 period and was 150 basis points, and the maximum drop in the interest rates was 381 basis points in the 3-month maturity. The Canadian interest rates have significantly decreased since 1990 and that is the reason why we observe the negative mean in the first differenced data.

Figure 4 (see Appendix B, pg.194) also shows the changing patterns of the Canadian zero-coupon yields from 2000 till 2013. For most of the time during 2000 we observed the inverted yield curve, but in 2001 the short-term rates fell and the curve transformed into a normal yield. Then in 2002 the short-term rates fall even further, making the yield curve pretty steep. Almost no change in the yield curve happens during 2003 and 2004, until in 2005 the long term interest rates fall slightly. In 2006 the short-term interest rates rise and the yield curve becomes flat. It stays flat until 2008 when the short term interest rates fall and the yield curve again comes to the normal state. In 2009 the short-term rates fall even further. Almost no change in the yield curve happens in 2010, and in 2011 the long-term rates experience downward shift. In 2012 the short-term rates do not change significantly, but middle and long-term interest rates fall down. From these observations, we learn that the yield curve can take many different shapes and can change its slope and magnitude in many ways. Our simulations of the term structure of the interest rates account for these changes and we model our random changes to approximate the real experience as close as possible.

5.3 Mortgage Rates and Loan Pricing Policy

Our simulation model is designed to price loans based on Treasury bond yields. A loan with a given time to maturity is priced to yield a rate equal to the treasury bond of the same

maturity plus a premium. We verified this model empirically by considering the mortgage rates and the Treasury bond rates of the same maturities over a number of years. These results are presented in Table 27, Table 28, Table 29 (see Appendix A, pg.112-114) and Figure 5, and Figure 6, Figure 7 (see Appendix B, pg.196-198). We find that the mortgage fixed rates are related to the rates on the Treasury zero-coupon bonds through almost a fixed premium. For one year mortgage rates this premium varies from 63 basis points to 462 basis points, and on average the premium is 200 basis points (Table 27 in Appendix A, pg. 112). In the 1990s the premium was quite small but it rose over years (Table 28 in Appendix A, pg. 113) and was much higher after 2000 (Table 29 in Appendix A, pg. 114). The largest spreads of more than 300 basis points are only observed during the October 2007 to November 2009 time period, the time known for the world financial crisis. Those days there was a high amount of uncertainty about the future interest rates and therefore, banks charged higher premiums on the fixed rate loans.[3]

Similarly, the rate on 3-year fixed rate mortgages is determined as the rate on 3-year treasury securities plus a premium. The premium varies from 99 basis points to 480 basis points, with a mean of 221 basis points (Table 27 in Appendix A, pg. 112). As in the case of the premium on 1-year fixed rate mortgage, the risk premium on 3-year fixed rate mortgage of more than 300 basis points is observed mostly during the time of the financial crisis, from September 2007 to March 2009. The risk premium was relatively small during the 1990s (Table 28 in Appendix A, pg. 113) but gradually increased to a higher level in the period of 200-2012 (Table 29 in Appendix A, pg. 114). The pattern of increase in the risk premium can be observed from Figure 6 (see Appendix B, pg. 197)**.**

The premium on 5-year fixed rate mortgage varies from 97 basis points to 456 basis points, with a mean of 240 basis points (Table 27 in Appendix A, pg. 112). The risk premium on

[3] We observed that small variance in the premium might be the result of round off errors. The Treasury bond interest rates are reported with many digits, but banks prefer to give their customers a quote that is convenient for reading and usually round the interest rate to the nearest hundredth.

the 5-year fixed rate mortgage is in general larger than the risk premium on lower maturities due to the higher risk of changes in the interest rates in the long-run. Nevertheless, similar to the one-year and three-year risk premiums the five-year risk premium was relatively small during 1990s (Table 28 in Appendix A, pg. 113) and increased significantly after 2000 and the world financial crisis (Table 29 in Appendix A, pg. 114). We observe that the risk premium of more than 300 basis points for 5-year fixed rate mortgages was experienced mostly after October 2007 and until December 2012. The large risk premium on the long-term mortgages in the recent years signals that banks believe that the interest rates are likely to increase in the future.

The risk to banks from fixed rate loans appears to be related to the possibility that their costs of funds might increase in the future while the rate on loans remain fixed by contracts. This risk is serious when the average time to maturity of the loans is higher than the average time to maturity of the deposits. This maturity mismatch is a normal for banks. Under this scenario, when rates rise profit margins will drop and may turn negative. Banks try to protect themselves from the rise in rates by adding risk premium to the loans. There is no risk from a decrease in the interest rates because a bank will be locked in higher interest rate payments on the old loans while the cost of funds drops.

Based on our analysis of the historical Treasury yields and mortgage rates we propose that the risk premium on mortgages should be modeled according to the following formula:

$$RPi = Constant * \sqrt[p]{M} \qquad (9)$$

where *constant* could be any positive value, *M* is the time to maturity of the loan measured in years, and *p* is the power. Usually long-term loans have higher premium than the short-term loans, and to account for that we multiply the constant premium by the maturity of the loan to the power p. Ideally, the *constant* in the risk premium on the fixed rate loans should equal the expected change in the interest rates. By fitting the empirical data, we find that the *p* should be equal to 0.1.

CHAPTER 6: RESULTS

6.1 Term Structure of the Interest Rates

One of the most important aspects of simulating a bank's operations is to forecast the term structure of interest rates. The yield curve can take one of several shapes, but we conduct simulations assuming only three shapes, namely normal, flat, and inverted. For our simulations, we assume that today, or Time 0, is December 2012 and our aim is to forecast the term structure of interest rates for 2013. We use the interest rates of December 2012 as our basis to predict the future rates.

6.1.1 Normal yield curve

We start the simulation of the yield curve at a time T with the initial rates on the zero-coupon Canadian government securities. We assume that the current economic environment is highly uncertain and the interest rates might either rise or fall during the next year. According to the simulation, the yield curve is stochastic and the interest rates randomly change every month. Usually the monthly change in interest rates is not large, and our simulation accounts for this fact. Figure 8 (see Appendix B, pg.199) presents the simulated pattern of changes of the yield curve during one year period.

As the simulation is run, some trends in the movements of the yield curve are observed. When we go from time T to T+1 the yield curve shifts downward, but the steepness stays almost the same. At time T+2 the yield curve changes direction and shifts upward. At time T+9 and T+10 the yield curve moves in a downward direction, then makes an upward turn at T+11 and almost does not change at T+12. Each time the yield curve follows a random magnitude of change and there is unlimited number of the possible scenarios of the future term structure of the interest rates. For example, we could look at the three different cases of the annual change in the yield curve presented in Figure 9 (see Appendix B, pg.201). It presents the three iterations of the model and every iteration shows a different pattern of change in the interest rates because the intercepts and magnitude of steepness are random variables. For example, the first scenario reveals that during 2013 the yield curve could shift up. In the second and third scenario the yield

curve shifts upward for the short-term maturities and downward for the long term maturities. Again, in these two scenarios we observe the different magnitude of changes. The Monte Carlo simulation accounts for different scenarios, giving us an opportunity to simulate the possible real world moves in the yield curve. All the three scenarios discussed above are close to the reality and the Canadian yield curve shows us the similar historical moves in the interest rates (Figure 4 in Appendix B, pg. 194).

6.1.2 Rising interest rates

The interest rates are at historic low now and many analysts are predicting a rise in the interest rates. We want to show a possible yield curve one year from now and next year we expect a rise in the interest rates by 100 basis points. We start with the same initial interest rates as of December 2012 and change the mean of the random disturbance from zero to a positive number. The monthly changes of the yield curve in this scenario are presented in Figure 10 (see Appendix B, pg.202) and the annual changes are presented in Figure 11 (see Appendix B, pg.204). The 3D presentation of the evolution of the term structure of interest rates over twelve months is presented in Figure 12 (see Appendix B, pg.205).

Although we predict a rise in interest rates for next year, the yield curve may follow different patterns of change in reaction to the market expectations. We may see an equal or different level of rise in the short-term and long-term rates. Sometimes the yield curve becomes steeper and sometimes flatter. The two simulations runs shown in Figure 12 (see Appendix B, pg.205) suggest that the final results may vary from run to run.

6.1.3 Flat or inverted yield curve

The economic conditions at this time suggest that we should not expect to observe an inverted yield curve any time soon. The fact that short term interest rates in the United States and in Canada are currently near zero there is not enough room for long term rates to be lower. Yet, our model is designed to work under all scenarios. In order to test the performance of our model in an inverted yield curve environment, we will use another point in time as our basis. Specifically, we use the base rates as the Canadian zero-coupon bond rates of December 2000.

The results of the simulation are presented in Figure 13 (see Appendix B, pg.207) and Figure 14 (see Appendix B, pg.209). Figure 13 depicts the monthly changes of the term structure of the interest rates. These changes are hard to notice from the graphs given that they are small. For this simulation, we assumed that the rates will experience an annual drop of 25 basis points. The assumption of small drop in rates is realistic given that rates are low and we need to insure that the rates do not drop below zero. The annual changes of the yield curve are presented in Figure 14 and they are more noticeable. Figure 15 (see Appendix B, pg.210) shows two three-dimensional graphs of the monthly changes in the yield curve over one year. As the graphs show, the yield curve is inverted but sometimes approaches the flat shape. We modeled the spread to be less steep because in a low interest rate environment it is unrealistic to assume that the yields on the securities with long-term maturities can be radically lower than yields on the securities with short-term maturities.

6.2 Modeling Banking Operations

We present four types of banks. Type I generates only net interest income and does not have any fee-based income components. Type II bank generates net interest income and traditional fee-based income. Type III bank generates net interest income, traditional fee-based income, and basic non-traditional fee-based income. Type IV bank generates net interest income and all spectrum of fee-based income from traditional, basic non-traditional and advanced non-traditional services.

6.2.1 Input variables

One of the most important aspects of simulation of a bank is input. We have to make assumptions about operations of a hypothetical bank and assign particular values to interest rates, deposit and loan rates. For example, in order to simulate a warm-up period of a bank we use historical rates from January 2003 till December 2012 and add to them a constant premium of 5%. This constant premium increases the level of rates but preserves the real shape of the Canadian yield curve.

In order to simulate operations of a bank we have to decide how much that bank would be charging its customers for loans and deposits. Our hypothetical bank is charging customers some administrative fees for managing their accounts and we set the value of administrative discount for deposit accounts to be 1%. Also our hypothetical bank charges administrative, default, and maturity premiums on loan rates. We set a premium on the variable rate loans to be 1% and the premium on fixed rate loans is set to be 2%. This number is based on the historical observations of average historical premiums on loans for the last 3 years. The value for the power term P is set at 0.1 based on historical observations and was obtained through a trial and error attempts to match the 1-year loan yields with 5-year loan yields. Moreover, we assume that the assets of our hypothetical bank have been growing since the opening of the bank and will continue to grow with the same speed. We assume a constant growth of assets to be 5%.

Our fee-based income is linked to GDP and oil price. We set the current GDP to $1,860,404 and GDP for the last year (T-12) to $1,720,748. Based on our empirical calculation of the average growth rate for Canadian GDP during 1990-2012 years, we assume that GDP will be growing 2% every year with a standard deviation of 1%. We set the oil price at the beginning of the simulation to $94.88. Based on the empirical observations of the average changes in the oil prices during 1990-2012, we assume that the oil price will be growing by 8.9% every year with a standard deviation of 4.45%. The discussed input variables will be the same for every simulation and for every type of a bank.

6.2.2 Type I Bank

We start our discussion with a hypothetical bank called Type I. We assume that this bank provides only intermediation services, takes money from depositors and lends to creditors, thus generating net interest income. As this income is the only one generated by our bank, we will call it Type I bank income for future reference. We simulate income of our hypothetical bank over five years under a stable economy scenario of no expected change in interest rates. Dollar value of average net interest income across five years could be observed in Table 30 (see Appendix A, pg.115). Our hypothetical bank can hold different amounts of fixed rate and variable rate loans and deposits; and based on the composition of the balance sheet, generated net interest income will be different. We present 121 possible balance sheet structures and see that

income is growing as the bank holds more fixed rate loans and deposits. This observation is expected because fixed rate loans are priced with the highest premiums and fixed rate deposits are priced with relatively highest administrative discounts. In order to see how different structures of balance sheet lead to different levels of Type I bank income, we present Table 31(see Appendix A, pg.116) that shows percentage changes in income as we add fixed assets or liabilities. We define the structure of the balance sheet where all loans and deposits have variable rate to be a benchmark according to which we will compare changes in income. This composition of the balance sheet has the lowest standard deviation of income across five years (Table 32 in Appendix A, pg.117) and therefore, brings the minimum interest rate risk to a bank. Type I bank income that is higher than the benchmark value means that a bank agrees to take additional risk in order to generate higher income. For example, the highest level of average income across five years is generated when all loans and deposits have fixed rates, but this composition also brings the highest volatility of income.

6.2.2.1 Scenario of change in interest rates

Term structure of interest rates is unlikely to be stable for the period of five years and we simulate Type I bank income under a scenario of changing interest rates. To begin, we expect a rise in interest rates of 25 basis points every year. We run the simulation for five years and present changes in income in Table 33 (Appendix A, pg.118). We observe that bank income only slightly changes from the rise in rates, and the maximum drop in income of 7% occurs for the balance sheet structure with all loans fixed and all deposits variable rate. Volatility of income will also rise for those balance sheet structures that have more fixed rate liabilities and more variable rate assets (Table 34 in Appendix A, pg.119). Other balance sheet structures are less sensitive to the change in term structure of interest rates and are unlikely to lead Type I bank to financial distress.

In order to see how income of our hypothetical Type I bank income could change when the change in rates is more dramatic, we consider a scenario when interest rates are rising by 75 basis points each year during the five years period. Table 35 (Appendix A, pg.120) presents these changes in net interest income for 121 different compositions of the balance sheet. The graphical representation of this table is shown in Figure 16 (Appendix B, pg.212). When interest rates rise,

there is a possibility of drop in the Type I bank income for some compositions of the balance sheet. Balance sheets with higher portion of fixed assets and lower portions of fixed liabilities will incur loss. For example, if a bank holds 80% fixed rate assets and 10% fixed rate liabilities and interest rates rise by 75 basis points every year, average net interest income will drop by 15%. However, if a bank holds 30% fixed rate assets and 70% fixed rate liabilities net interest income will rise by 12%. The largest positive change in income occurs when all liabilities are fixed rate and all assets are variable rate. In this case income of a bank from loans will be growing as rates grow, but the expense in terms of fixed payments on deposits will be stable. Table 36 (Appendix A, pg.121) presents average change in standard deviations of income across five years given 75 basis points rise in interest rates every year. Standard deviations follow the same change structure as income; deviations significantly increase as liabilities shift from variable to fixed rate but decrease as assets become more fixed. The maximum volatility is observed when all assets are variable and all liabilities are fixed. This composition of balance sheet also shows the largest positive change in income, confirming the theory that the higher return is associated with the larger risk. Nevertheless, there are some compositions of balance sheet that make bank income insensitive to changes in rates. These compositions are shown by the green surface in Figure 16 (Appendix B, pg.212) and may lead to a maximum of 5% decrease in income when rates rise 75 basis points every year.

One might claim that Type I bank is better off by holding the minimum amount of the fixed rate assets and maximum amount of fixed rate liabilities. Nevertheless, these types of the balance sheet structures only benefit from the rise in the interest rates. Interest rates are hard to predict and they may drop during the five year period. If we simulate a drop in the interest rates of 75 basis points every year (see Table 37 in Appendix A, pg.122; and Figure 17 in Appendix B, pg.207), we obtain an opposite picture of the changes in income when rates were rising. Now, if a bank holds 80% fixed rate assets and 10% fixed rate liabilities and interest rates drop by 75 basis points every year, average income will increase by 15%. And if a bank holds 30% fixed rate assets and 70% fixed rate liabilities, average income will drop by 12%. We observe that in the decreasing rate environment banks are better off by holding the maximum amount of fixed rate assets and the minimum amount of the fixed rate liabilities. This implies that a bank will be locked in a high income from loans but the payment on variable deposits will be decreasing due

to drop in the interest rates. However, in this scenario the volatility of earnings is also the highest. Table 38 (see Appendix A, pg.123) shows that change in average standard deviation when rates are falling is exactly opposite to the changes presented in Table 36 (see Appendix A, pg.121). Standard deviation of average income will significantly increase as a bank holds more fixed rate assets and less fixed rate liabilities; but will decrease for other balance sheet structures.

It is interesting to note that small change in rates will not significantly reduce Type 1 bank income. Even dramatic change in rates will be still safe for some balance sheet structures. Both Figure 16 and Figure 17 (see Appendix B, pg.212-213) present balance sheet structures where change in income does not exceed 5%. These structures are highlighted with green color and include almost equal amounts of fixed rate assets and fixed rate liabilities. A bank holding similar balance sheets probably does not have to do any hedging because the asset liability mix is well matched. However, other balance sheet structures require hedging because a drop in bank profits could lead to the bankruptcy of Type I bank.

6.2.2.2 Hedged income

Based on above results, we decide that changes in Type I bank income assuming 75 basis points expected increase in rates should be hedged to avoid large losses. The hedging tool we use is Eurodollar futures contracts. We estimate the difference for every year between the simulated income with and without change in interest rates, and finance this difference through gains or losses from derivative contracts. The purpose of hedging is to stabilize income and avoid volatility no matter how interest rates move. If there is a negative change in income when rates increase, we short the futures contracts; and if there is a positive difference in income, we long the futures. Hedging is performed on a yearly basis with the expectation that rates will be rising every year. We enter futures positions in the beginning of a year and long or short 90-days Eurodollar futures that mature at the end of the year. We simplify marking to market and assume that gains or losses on our futures positions will be realized at the end of every year.

After introducing hedging and simulating Type I bank income under scenario of 75 basis points rise in rates every year, we notice that bank income is stabilized. Table 39 (see Appendix A, pg.124) shows that there is almost zero difference between the average five year incomes when rates are constant and when rates rise. Table 40 (see Appendix A, pg.125) shows that the

standard deviations change slightly due to the changes in rates but the changes are not statistically significant. Hedging works even when our prediction of rates is wrong and rates actually fall by 75 basis points every year. Table 41 (see Appendix A, pg.126) shows that there is almost zero change in income for every structure of balance sheet even when rates fall. Similarly, hedging also decreases volatility of average income and keeps it at the same levels as if there was no change in interest rates (see Table 42 in Appendix A, pg.127). We conduct F-test for differences in volatilities and conclude that at 5% significance level there is no significant difference between the volatility of hedged income and income that was generated when there is no change in the term structure of interest rates.

6.2.3 Type II Bank

Type II bank generates net interest income and some fee-based income that is related to the origination of loans and deposits. This fee-based income is called traditional and is generated through deposit and payment services, lending fees, and card fees. Table 43 (see Appendix A, pg.128) presents a dollar value of Type II bank income for 121 different balance sheet structures. One can notice that the level of income is higher than that generated for Type I bank because we add extra income from traditional fee-based services. Still, Type II bank income keeps the same pattern of income across the various balance sheets as Type I income; the level of income increases for fixed rate assets and liabilities and decreases for variable rate assets and liabilities. Table 44 (see Appendix A, pg.129) presents average standard deviation of Type II bank income during five years. F-test shows that these standard deviations are not significantly different from Type I bank income standard deviations. With the higher levels of income but the same income variability, Type II bank seems to provide higher return given the same level of risk than Type I bank.

6.2.3.1 Scenario of change in interest rates

We consider the scenario of rising rates during five year period and analyze the impact of the change in interest rates on Type II bank income. The average change in income given 25 basis points rise in rates is presented in Table 45 (see Appendix A, pg.130). We can observe that

income rises for the balance sheet structures with more variable rate assets and fixed rate liabilities. Income decreases for those balance sheet structures that hold more fixed rate assets and variable rate liabilities. However, the decrease in income is not large and income can drop by maximum of 5%. Volatility of income also does not change much (see Table 46 in Appendix A, pg.131).

However, when we consider more dramatic change in rates, for example, a rise of 75 basis points every year, income can possibly drop by large percentage (see Table 47 in Appendix A, pg.132). In this case, if a bank holds 80% fixed rate assets and 10% fixed rate liabilities, average Bank II income will drop by 11%. However, if a bank holds 30% fixed rate assets and 70% fixed rate liabilities income will rise by 9%. In the scenario of falling interest rates the change in income will be the same percentage but in the opposite direction: it will rise by 11% and fall by 9% for the two balance sheet structures discussed previously (see Table 49 in Appendix A, pg.134). It is interesting to note that changes in income for Type II bank are smoother than for Type I bank; therefore, suggesting that traditional fee-based income could help a bank to avoid large drops in income. We also notice that there is a significant change in volatility of Type II bank income for most of balance sheet structures as rates either rise or fall (see Table 48 and Table 50 in Appendix A, pg. 133 and pg. 135).

As in the case of Type I bank, Type II bank also has some balance sheet structures that will minimize changes in income and keep the income almost at the same level independently of moves in rates (see Figure 18 in Appendix B, pg.215). These structures are larger in number than for Type I bank. If Type II bank holds those balance sheet structures it can be safe without hedging. However, if Type II bank holds different balance sheet structures it should hedge its income.

6.2.3.2 Hedged income

In order to stabilize Bank II income volatility and avoid dramatic changes in income we conduct hedging. We simulate Type II bank income and estimate the difference between income with and without rise in rates. This difference is then expected to be gained or lost from the positions in futures contracts. Based on this difference in incomes we enter derivatives positions and run the simulation with Eurodollar futures.

Table 51 (see Appendix A, pg.136) shows that hedging works when rates rise and Type II bank income stays at the same level as if rates were constant. Volatility of the hedged Type II bank income will also stay at the same level as if there was no change in interest rates (see Table 52 in Appendix A, pg.137). Moreover, even if interest rates end up declining, contrary to the forecast, hedging will stabilize the income (see Table 53 in Appendix A, pg.138). Table 54 (see Appendix A, pg.139) shows the percentage change in volatility of income when rates fall. F-tests show that the percentage changes in volatility of Type II bank hedged income are not significantly large at 5% significance level.

6.2.4 Type III Bank

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. These services provide a stable stream of income to a bank and therefore, the level of total income rises for every balance sheet structure of a bank (see Table 55 in Appendix A, pg.140). However, volatility of income relative to Type I bank income also rises for some balance sheet structures (see Table 56 in Appendix A, pg.141). Those balance sheet structures that hold less than 30% fixed liabilities will experience a significant rise in volatility. Volatility of Type III bank income even rises relative to Type II bank income for some balance sheet structures. Balance sheets that hold less than 20% fixed rate liabilities and less than 30% fixed rate assets will experience significant rise in volatility. However, if a bank holds higher portions of fixed rate assets and fixed rate liabilities the risk return tradeoff actually improves, because a bank will generate higher income given the same level of volatility.

6.2.4.1 Scenario of change in interest rates

A scenario of rising rates during five year period can either positively or negatively impact Type III bank income. Table 57 (see Appendix A, pg.142) shows that if rates rise by 25 basis points each year income will improve for balance sheet structures that hold more fixed rate

liabilities but less fixed rate assets, and deteriorate otherwise. Still, the change in income is not significant and can only lead to a maximum drop of 4% in income. Changes in volatility are also small (see Table 58 in Appendix A, pg.143).

When we consider more dramatic change in rates, Type III bank income changes with a larger magnitude; however, changes in income are much lower than for Type I and Type II banks (see Table 59 and Table 61 in Appendix A, pg.144 and pg. 146). If a Type III bank holds 80% fixed rate assets and 10% fixed rate liabilities and interest rates rise by 75 basis points every year, average total income will drop only by 9% (Table 59 in Appendix A, pg.144). However, if a bank holds 30% fixed rate assets and 70% fixed rate liabilities income will rise by 7%. In the scenario of falling interest rates the change in income will be the same percentage, but with an opposite direction: it will rise by 9% and fall by 7% for the two balance sheet structures discussed previously (Table 61 in Appendix A, pg.146).

When interest rates either rise or fall by 75 basis points each year, volatility of income significantly increases for particular balance sheet structures but decreases for others (see Table 60 and Table 62 in Appendix A, pg.145 and pg.147). The pattern of percentage changes is similar to the ones observed for banks Type I and Type II.Type III bank has some balance sheet structures that do not react to dramatic changes in interest rates and keep the income within 5% change (see Figure 19 in Appendix B, pg.216). The number of these portfolios is larger for Type III bank than for Type I and Type II banks. Nevertheless, other balance sheet structures require hedging in order to keep income changes within a reasonable range.

6.2.4.2 Hedged income

In order to avoid dramatic changes in income and keep income volatility within a reasonable range we conduct hedging for Type III bank. We simulate Type III bank income and estimate the difference between income with and without rise in rates. This difference is then expected to be gained or lost from the positions in futures contracts. Based on this difference in incomes we enter the derivatives market by selling or buying Eurodollar futures and run the simulation.

Hedging keeps the average dollar value of income and volatility almost at the same levels, no matter how rates change (see Table 63-66 in Appendix A, pg.148-151).

6.2.4.3 Introducing operational costs

Generation of basic fee-based income is not possible without some costs. These costs include salaries to employees, rent, technology, and marketing costs. After introducing these costs to Type III bank we simulate an average dollar value and volatility income after costs, called earnings before interest and taxes (EBIT) for the future reference (see Table 67 and Table 68 in Appendix A, pg.152-153). Because operational costs are deducted from the gross income, Type III bank EBIT is lower than Type III bank income. However, the volatility of EBIT is similar in magnitude to the volatility of income.

Change in interest rates leads to larger magnitude of change in Type III bank EBIT than it was for income without costs (see Table 69, Table 71, Table 73 in Appendix A, pg.154, 156, 158; and Figure 20 in Appendix B, pg.217). However, deducting costs do not significantly change volatility (see Table 70, Table 72, Table 74 in Appendix A, pg.155, 157, 159). Hedging of EBIT generates the same results as hedging of Type III income. The dollar value and volatility of EBIT decrease to the levels that are observed when there was no change in rates (see Table 75-78 in Appendix A, pg.160-163).

6.2.5 Type IV Bank

Type IV bank is the most complete bank and generates net interest income and all sources of fee-based income: traditional, basic non-traditional and advanced non-traditional. Advanced non-traditional income is generated through investment management, underwriting services, and trading. These services require economies of scale and only large banks can afford to offer these services. The dollar value of total income generated by Type IV bank is the largest among all types of banks (see Table 79 in Appendix A, pg.164). However, volatility of Type IV bank income is also the largest among all types of banks (see Table 80 in Appendix A, pg.165). The average standard deviation of income is significantly large for Type IV bank than for Type I, Type II, and even for Type III bank.

6.2.5.1 Scenario of change in interest rates

In the scenario of rising interest rates Type IV bank income increases for the balance sheet structures that have more fixed rate liabilities and variable rate assets and decreases otherwise (see Table 81 in Appendix A, pg.166). Still change in income is not significant and can only lead to a maximum drop of 4%. Change in volatility is also small (see Table 82 in Appendix A, pg.167).

Larger increase in interest rates will lead to larger changes in income. For example, if rates rise by 75 basis points every year during the five year period a bank with a balance sheet structure having 80% fixed rate assets and 10% fixed rate liabilities will incur a loss of 8% of income. However, if a bank instead would hold 30% fixed rate assets and 70% fixed rate liabilities its income will increase by 7% (see Table 83 in Appendix A, pg.168; and Figure 21 in Appendix B, pg.218). In the scenario of falling interest rates the change in income will be almost the same percentage but with an opposite direction: it will rise by 8% and fall by 6% for the two balance sheet structures discussed above (see Table 85 in Appendix A, pg.170).

Volatility of Type IV bank income also either rises or falls for specific balance sheet structures when there is 75 basis points change in interest rates every year (see Table 84 and Table 86 in Appendix A, pg.169 and pg. 171). Changes in volatility follow the same pattern as changes in income; higher returns are associated with higher risks. For example, when rates are rising volatility is increasing for balance sheet structures holding more fixed rate liabilities and variable rate assets.

As in the case of other types of banks, Type IV bank also has some balance sheet structures that react by only small change in income to the dramatic changes in the term structure of interest rates. These balance sheet structures may not require hedging, but other structures do.

6.2.5.2 Hedged income

In order to stabilize the Type IV bank income volatility and avoid dramatic changes in income we conduct hedging. Hedging stabilizes the average dollar value of income and the volatility is controlled at the same levels that were observed when there was no change in rates (see Table 87-90 in Appendix A, pg.172-175).

6.2.4.3 Introducing operational costs

Non-traditional income is usually associated with high costs. Salaries of professionals who work in investment banking, underwriting and trading floors could be very large. The costs associated with nontraditional income are fixed and independent of the market conditions. The income we get after deducting all costs is called EBIT. We simulate the average dollar value and volatility of Type IV bank EBIT (see Table 91 and Table 92 in Appendix A, pg.176-177) and notice that the dollar value of EBIT is lower than the dollar value of income but the volatility of EBIT seems to be similar to the volatility of income. Moreover, operational leverage may lead to larger losses in EBIT when there is a change in interest rates (Table 93, Table 95, and Table 97 in Appendix A, pg. 178, 180 and 182; and Figure 22 in Appendix B, pg.219). For example, the maximum percentage loss in income Type IV bank could incur when rates drop by 75 basis points every year is 15%. However, when we introduce costs the loss in EBIT could be as large as 36%. In addition, EBIT volatility is almost similar to gross income volatility when interest rates change (see Table 94 and Table 96, Table 98 in Appendix A, pg.179, 181, 183). Hedging EBIT stabilizes the dollar value and volatility of EBIT at the levels that are obtained under conditions of stable interest rates (see Table 99-102 in Appendix A, pg.184-187)

6.2.6 Comparing banks in terms of risk-return tradeoff

In order to better understand risks associated with different fee-based services, we will look at coefficient of variation for all types of banks. The coefficient of variation roughly measures the level of risk per unit of return and the lower value is more favorable. Tables 103-108 in Appendix A (pg. 188-190) presents the coefficient of variation for every balance sheet structure in every type of bank. Firstly we compare banks' income without considering any costs. The leader in the lowest risk per unit of return is Type III bank that generates net interest income, traditional fee-based income and basic nontraditional fee-based income. Type II bank has slightly higher risk per unit of return, and Type IV bank has significantly higher risk per unit of return than Type I and Type II banks. Although Type I bank has the highest risk per unit of return among all types of banks, it should not be included into comparisons because it does not generate any fee-based income.

Fee-based income is associated with some costs and it is important to take them into consideration while analyzing risk-return tradeoff for our banks. Unfortunately, due to unavailability of data we cannot estimate fee-based expense for Type II bank and therefore, we only can compare Type III bank and Type IV bank. When we deduct operating costs from income of those banks, the coefficient of variation significantly rises. Still, risk per unit of return for Type III bank EBIT is lower than for Type IV bank EBIT. This observation suggests that basic non-traditional fee-based activities are safer than advanced. The same conclusion could be made by looking at 3D graphs depicting changes in EBIT given changes in interest rates. High volatility of income that is brought by advanced non-traditional fee-based services could be seen from Figure 22 (see Appendix B, pg.219). We can observe high hills on the surface that signal about high volatility of EBIT for every balance sheet structure. Interestingly, these hills are larger than in Figure 21 (see Appendix B, pg.218), and that signals about higher volatility of income when costs are considered. Type IV bank EBIT has higher volatility than Type III bank EBIT because hills are much smaller on the surface for Type III bank.

6.2.7 Robustness check

We conduct a robustness check by simulating increase and decrease in interest rates every year by 25 and 50 basis points. Having different changes in interest rates does not change our results. We also tried to hedge only net interest income component of every type of a bank and this hedging strategy did not yield any significantly different results.

We also use an alternative method to calculate costs associated with fee-based services. We obtain the operating expense from six largest Canadian banks for the last three years (2010, 2011, and 2012), their size of loans and size of deposits. Then we calculate the ratio of costs to loans and costs to assets. On average, the cost per dollar of loans is 0.035 and the cost per dollar of assets is 0.018. Running simulations with alternative measures of operating costs does not alter our results.

CHAPTER 7: CONCLUSIONS, IMPLICATIONS, AND DIRECTIONS FOR FUTURE RESEARCH

This paper aims to analyze fee-based income and its impact on risk and hedging activities in Canadian banks. Banks in Canada have relatively recently engaged into non-traditional fee-based activities; and although previous research analyses the impact of those services on bank income in different countries, none of the studies investigated the Canadian case. Canada has its own structure of banking industry, has different policies and regulations and therefore, banking practices are unique. Large Canadian banks share a rapid growth of fee-based income over the last twenty years, and today fee-based income is equally important as net interest income. Different fee-based services might have different impact on volatility of bank income and sometimes may even lead a bank to financial distress. Therefore, it is very important to analyze fee-based income in Canadian banks and analyze possible hedging techniques that will help banks to avoid a financial distress.

The methodology we are using in this paper is Monte-Carlo simulation of a hypothetical Canadian bank. Simulation allows us to analyze different economic scenarios under conditions of uncertainty and therefore, enables us to generate results that are close to reality. In order to create an effective model, we empirically analyze bank revenues from fee-based services, the Canadian yield curve, and historical loan rates in Canadian banks and incorporate our findings into the simulation model. We try to make analysis of almost all possible types of commercial banks and take into consideration different balance sheet structures and different services banks can have.

7. 1 The Results

We find that fee-based income has been growing rapidly in Canadian banks and its share of total revenues has increased from 30% in early 90s to approximately 50% in late 2000s and remains stable at this level. Fee-based income can be divided into two components, traditional fee-based income and non-traditional fee-based income. Traditional fee-based income is generated through services Canadian banks have been offering for a long period of time, such as deposit and payment, loan and card services. Non-traditional income is generated through the

services that appeared in Canadian banks after 1987. These services can be further divided into basic and advanced. Basic services can be offered by majority of banks, but advanced services require specialized knowledge and economies of scale. We find that non-traditional income in Canadian banks is almost twice as large as traditional fee-based income. The major share of non-traditional fee-based income comes from securities commissions and brokerage fees, and the major share of traditional fee-based income comes from deposit and payment services. We also find that share of income coming from basic non-traditional services has significantly increased after 2000 and became larger than the share of income coming from advanced non-traditional services. This observation signals that Canadian banks became more engaged into insurance, mutual fund, and securitization business. We find that the most volatile stream of income is generated through trading and insurance activities. Nevertheless, insurance always generates a positive income stream for banks. Trading, on the other hand, can generate huge loss and lead a bank to a financial distress. Moreover, securities held by a bank as assets can also generate loss for banks, but not as large loss as trading activities. Due to the possibility of loss we find a negative correlation coefficient between trading and net interest incomes, and securities gains or losses and net interest income. All other fee-based income sources share high correlation coefficients with net interest income. This observation signals about low diversification opportunity between net interest income and fee-based income in Canadian banks. However, we find some diversification opportunities within fee-based income because of some low correlation coefficients among fee-based income sources. Moreover, we find high positive correlation coefficients of fee-based income sources and some macroeconomic variables. We find that Canadian Gross Domestic Product (GDP) has a significant relationship with most of fee-based income sources, lagged GDP has a significant relationship with securitization revenue, and oil prices have significant relationship with underwriting revenue. Therefore, we use these macroeconomic variables to model fee-based income in our Monte-Carlo simulation. However, we find that trading activity is not related to any macroeconomic factors and income generated through trading cannot be predicted.

We also empirically analyze Canadian term structure of interest rates and find that on average, Canadian yield curve has a normal upward sloping shape, with lower rates on short maturities and higher rates on long maturities of Treasury bonds. The standard deviation of rates

in the yield curve is usually half of the mean value. We also analyze annual changes in the Canadian yield curve and find that the maximum annual decrease in rates was 381 basis points and maximum annual rise in rates was 150 basis points. Nevertheless, on average, interest rates change by 40 basis points every year. We incorporate these findings into our Monte-Carlo simulation of a hypothetical bank and model the term structure of interest rates that can take similar moves as Canadian yield curve.

In our simulation model we link rates on loans and deposits to the term structure of interest rates. In order to generate a sound relationship among the rates, we empirically analyze connection of Canadian mortgage rates to the Treasury bond yields. We find that mortgage rates are tied to bond yields through a fixed premium that increases with maturity of mortgage and Treasury bond. Based on these observations, we develop a formula that closely simulates the real relationship between loan rates and the yield curve in our simulation model.

In order to test our hypotheses, we assume that there could be four types of banks that have different services. Type I Bank provides only intermediation activities and only generates net interest income. Type II Bank in addition to intermediation activities provides traditional fee-based services. Type III Bank provides intermediation, traditional and basic non-traditional services. And Type IV Bank provides all spectrums of intermediation and fee-based services.

We find that all types of banks can succeed in natural hedging and avoid financial distress as long as there is no dramatic change in interest rates. However, even if interest rates change dramatically all types of banks have some optimal structures of balance sheet for which the change in income will not be significant and a bank will avoid financial distress. Therefore, the sample evidence suggests that both Hypothesis 1 and Hypothesis 3 can be accepted and banks holding optimal composition of balance sheet and engaged in either only traditional banking or both traditional and non-traditional banking can avoid financial distress.

We find that both traditional and basic non-traditional fee-based income could be a good tool for hedging against interest rate risk due to their almost stable stream of income. Type III bank has the lowest risk per unit of return, suggesting that banks are better off by providing intermediation, traditional fee-based and basic non-traditional fee-based services. Provision of advanced non-traditional fee-based services significantly increases interest rate risk, but due to high volatility does not necessary increase return. This observation suggests us to accept

Hypothesis 4, but only for traditional fee-based services and basic-non-traditional fee-based services. These services generate the safest income stream that could be used as hedging against interest rate risk.

In general, non-traditional fee-based income could be quite risky; and therefore, it requires hedging. When we account for costs associated with fee-based income, we find that a bank does not need to hedge both fee-based and interest income and hedging just net interest income component will yield safe and stable revenues. Therefore, we accept our Hypothesis 2 and suggest that any bank can avoid financial distress with just moderate positions in futures covering only part of income.

7.2 The Implications

The findings of our study have useful implications for managers, academics, and policy makers. Bank managers can now use a realistic simulation model for forecasting possible changes in income under different economic scenarios. Moreover, they could use simulation to determine the optimal hedging ratio based on the forecasted changes in revenues. Bank managers may also use swap derivatives to achieve the optimal composition of balance sheet that will be not sensitive to moves in the interest rates or use less futures contracts and hedge only net interest income component of total income. Banks that wish to minimize the interest rate risk may choose to focus only on traditional fee-based services that have lowest risk per unit of return.

This research does not only complement the existing literature with Canadian example for fee-based income but also broaden and deepen understanding of fee-based income in general. We propose and test a theory that fee-based income sources are related to the macroeconomic activity and therefore, some macroeconomic factors can significantly affect fee-based revenue generation process in banks. Moreover, we present a new division of fee-based income components into traditional, basic non-traditional and advanced nontraditional income. And unlike previous studies, we introduce costs associated with each of those components. We compliment the banking literature with a realistic simulation model that could be used not only in academia but also in a risk management department of any bank.

Our study also have some useful implications for policy makers because it sheds light on operations of Canadian banks, their sensitivity to changes in interest rates and other macroeconomic factors, and most importantly, possibility of default. Government officials should not worry about traditional and basic non-traditional services offered by Canadian banks. Instead, they should bring more attention to the risky advanced non-traditional activities in those banks, especially trading.

Overall, this study provides a realistic and simple model that could be used by anyone to analyze the impact of future macroeconomic and financial activity on profitability and stability of banks. We applied the model for Canadian commercial banks, but this method could be applied anywhere in the world. The uniqueness of our model is that it gives insight about the future activity taking into account past and present information.

7.3 The Limitations, the Possible Extensions, and the Directions for Future Research

Despite the above implications, our study has some limitations. In our empirical research we analyze just six Canadian banks because only they offer advanced non-traditional services. Although these banks represent a majority of Canadian banking market, our analysis of fee-based income could be extended by including other Canadian banks as well. Moreover, even within these six banks the starting date of offering fee-based services is not consistent. Our data is limited to twenty two years, but due to no income collected from several fee-based services by some banks in earlier years, we had to cut our sample and include only those years when the service was provided by at least three banks.

Methodology of this study also has some limitations and can be extended. For example, we significantly simplify the model of bank and introduce some assumptions about no prepayments and no early withdrawal of loans or deposits. We assume that a bank holds loans and deposits that have maturity up to five years and that a bank holds the same dollar value for each maturity within each loan or deposit class. The model can be extended by relaxing the above assumptions.

Due to the unavailability of fee-based income data on a monthly basis, we only simulate the annual income statement. If banks start to report monthly fee-based income data, an

extension of the study could also be running simulation with a higher frequency, daily or weekly instead of monthly. Moreover, simulations of bank income could be extended to more than five years.

Future research may include different hedging techniques by using futures and options. Moreover, future research may try to find an optimal level of different fee-based services that will maximize the profit of a bank without increasing risks.

REFERENCES

Alessandri, P., & Drehmann, M. (2010). An economic capital model integrating credit and interest rate risk in the banking book. *Bank of England.Quarterly Bulletin, 50*(2), 129.

Allen, L., Jagtiani, J. (2000). The Risk Effects of Combining Banking, Securities, and Insurance Activities. *Journal of Economics and Business,* 52, 485 – 497.

Ananymous (1995). The case for risk-based pricing. *American Bankers Association. ABA Banking Journal, 87*(1), 58-68.

Asay M., Gonzalez G., Wolkowitz B. (1981). Financial Futures, Bank Portfolio Risk, and Accounting. *The Journal of Futures Markets*, 1, 607-618.

Athanasoglou P., Brissimis S., Delis M. (2008). Bank-specific, industry-specific and macroeconomic determinants of bank profitability. *Journal of International Financial Markets, Institutions and Money*, 18, 121-136.

Arpa, M., I. Giulini, A. Ittner, and F. Pauer. (2001). The Influence of Macroeconomic Developments on Austrian Banks: Implications for Banking Supervision. *BIS Papers 1*, 91–116.

Baele, L., De Jonghe, O., Vennet, R.V. (2006). Does the stock market value bank diversification? *Journal of Banking & Finance*, 31, 1999–2023.

Baldan, C., Zen, F., & Rebonato, T. (2012). Liquidity risk and interest rate risk on banks: Are they related? *IUP Journal of Financial Risk Management, 9*(4), 27-51.

Bashir, A. (2000), Determinants of Profitability and Rates of Return Margins in Islamic Banks: Some Evidence from the Middle East, Grambling State University, Mimeo.

Belghitar, Y., Clark, E., & Judge, A. (2008). The value effects of foreign currency and interest rate hedging: The UK evidence. *International Journal of Business*, 13(1), 43-60.

Bernhardsen, E., & Larsen, K. (2003). Banks' pricing of risk associated with corporate lending. *Norges Bank.Economic Bulletin, 74*(1), 24-34.

Bikker, J. A. and H. Hu. (2002). Cyclical Patterns in Profits, Provisioning and Lending of Banks. DNB Staff Reports, 86.

Black F., Derman E., and Toy W. (1990). A one factor model of interest rates and its application to Treasury Bond options, *Financial Analysts Journal*, 46, 33-39.

Black F., Karasinki P. (1991). Bond and option pricing when short rates are lognormal. *Financial Analysts Journal*, 47, 52-59

Bolder D.J., Johnson G., Metzler A. (2004). An empirical analysis of the Canadian term structure of zero-coupon interest rates. Working Paper.

Booth J., Smith R., and Stolz R. (1984). Use of Interest rate Futures by Financial Institutions. *Journal of bank research*, 15, 15-20.

Booth, J. R., & Chua, L. (1995). Structure and pricing of large bank loans. *Economic Review - Federal Reserve Bank of San Francisco*

Boyd, J., Graham, S. (1988). The Probability and Risk Effects of Allowing Bank Holding Companies to Merge With Other Financial Firms: A Simulation Study. *Federal Reserve Bank of Minneapolis Quarterly Review*, 12, 3 – 17.

Brewer III E. Jackson III W.E., Moser J.T. (2001). The value of using interest rate derivatives to manage risk at U.S. banking organizations, *Economic Perspectives, Federal Reserve Bank of Chicago*, Working Paper

Brodt A.I. (1988). Optimal Bank Asset and Liability Management with Financial Futures, *The Journal of Futures Markets*, 8, 457-481

Broll U., Schweimayer G. and Welzel P. (2003), Managing Credit Risk with Credit and Macro Derivatives. *University of Augsburg Economics Discussion Paper No. 252*.

Brown G. (2001). Managing foreign exchange risk with derivatives, *Journal of Financial Economics*, 60, 401-448.

Burgstaller J. (2006). Bank Income and Profits over the Business and Interest Rate Cycle. Johannes Kepler University of Linz. Department of Economics, Working Paper 0611.

Cheang, N. (2005), How Do Interest Rate Movements Affect Interest Margin of Macao Banks? *AMCM Quarterly Bulletin*, 15, 51-74.

Ciccehetti P., Dale C., Vignola A. (1981). Usefulness of Treasury bill Futures as Hedging Instruments. *The Journal of Future Market*, 1, 379-387.

Coleman A.D.F, Esho N., and Sharpe I.G. (2002). Do bank characteristics influence loan contract terms? *Working paper, University of New South Wales*.

Coroneo L., Nyholm K., and Vidova-Koleva R. (2008). How arbitrage-free is the Nelson-Siegel model? Working paper.

Cox J.C., Ingersoll J.E., Ross S.A. (1985b). A theory of the term structure of interest rates, Econometrics, 53, 385-407

Demirguc-Kunt, A., Huizinga H. (1999). Determinants of Commercial Bank Interest Margins and Profitability: Some International Evidence. *World Bank Economic Review*, 13, 379-408.

DeYoung, R.D., Roland, K. (2001). Product Mix and Earnings Volatility at Commercial Banks: Evidence from a Degree of Leverage Model. *Journal of Financial Intermediation*. 10, 54 – 84.

DeYoung, R.D., Rice, T. (2004a). How Do Banks Make Money? The fallacies of fee income. *Federal Reserve Bank of Chicago.* Fourth Quarter, 34-51.

DeYoung, R.D., Rice, T. (2004b). Noninterest Income and Financial Performance at U.S. Commercial Banks. *The Financial Review*, 39, 101 – 127.

DeYoung, R., Torna, G. (2013). Nontraditional banking activities and bank failures during the financial crisis. *Journal of Financial Intermediation, 22*(3), 397-421.

Drehmann, M., Sorensen, S., and Stringa, M. (2010). The integrated impact of credit and interest rate risk on banks: A dynamic framework and stress testing application. *Journal of Banking & Finance*, *34*(4), 713-729.

Ederington L. (1979). The hedging Performance of the New Futures Markets. *Journal of Finance*, 34, 157-170.

Elsas, R., Hackethal, A., Holzhauser, M. (2010). The anatomy of bank diversification. *Journal of Banking & Finance*, 34, 1274 – 1287.

Estrella, A. (2001). Mixing and matching: Prospective financial sector mergers and market valuation. *Journal of Banking & Finance,* 25, 2367 – 2392.

European Central Bank (2000), EU banks' income structure. Special Publication.

Fields, L.P., Fraser, D., Kolari, J. (2007). Is Bancassurance a Viable Model for Financial Firms? *The Journal of Risk and Insurance*, 74, 777 – 794.

Flannery M. (1981). Market interest rates and Commercial Bank Profitability: An Empirical Investigation. *The Journal of Finance,* 36, 1085-1101.

Flannery M. (1983). Interest Rates and Bank Profitability: Additional Evidence. *Journal of Money, Credit and Banking*, 15, 355-362.

Flannery, M. (1986). Asymmetric information and risky debt maturity choice. *Journal of Finance*, 41, 19-37.

Frankle C. (1980). The hedging performance of the new futures markets: comment. *Journal of Finance,* 35, 1273-1279.

Freedman C. (1998). The Canadian Banking System. *Technical Reports 81*, Bank of Canada.

Gallo, J. G., Apilado, V. P., and Kolari, J. W. (1996). Commercial bank mutual fund activities: Implications for bank risk and profitability. *Journal of Banking & Finance*, *20*(10), 1775-1791.

Gart, A., & Pierce, E. M. (1998). WHY DO LARGE U.S. BANKS OUTPERFORM THEIR EUROPEAN COUNTERPARTS? *Studies in Economics and Finance*, *19*(1), 27-47.

Gibson R, Lhabitant F.-S., and Talay D. (2010). Modeling the term structure of interest rates: a review of the literature. *Foundations and Trends in Finance*, 5, 1-156.

Goldfarb D. (1987). Hedging interest rate risk in banking. *The Journal of Futures Market,* 7, 35-47.

Gottesman, A.A., Roberts G.S. (2004). Maturity and corporate loan pricing. *The Financial Review*, 39, 55-77.

Grant D., Hempel G.(1982). Bank portfolio management: The role financial futures. Proceedings of a conference on bank structure and competition, *Federal Reserve Bank of Chicago.*

Hannan T.H. (1991). Foundations of the Structure-Conduct-Performance Paradigm in Banking. *Journal of Money, Credit and Banking*, 23, 68-84.

Hannan T.H., Berger A.N. (1991). The Rigidity of Prices: Evidence from the Banking Industry. *The American Economic Review*, 81, 938-945.

Hannan T.H, Liang J.N. (1993). Inferring market power from time-series data: The case of the banking firm. *International Journal of Industrial Organization*, 11, 205-218.

Hanweck, G., Kilcollin T. (1984). Bank Profitability and Interest Rate Risk. *Journal of Economics and Business*, 36, 77-84.

Harjoto, M., Mullineaux, D. J., & Ha-Chin, Y. (2006). A comparison of syndicated loan pricing at investment and commercial banks. *Financial Management*, *35*(4), 49-70.

Hartmann-Wendels, T. (2004). Discussion of "managing credit risk with credit and macro derivatives". *Schmalenbach Business Review: ZFBF*, 56(4), 379-381.

Hendrickson, J. M., & Nichols, M. W. (2001). How does regulation affect the risk taking of banks? A U.S. and Canadian perspective. *Journal of Comparative Policy Analysis*, *3*(1), 59.

Helwege J and Turner C.M. (1999). The Slope of the Credit Yield Curve for Speculative-Grade Issuers. *The Journal of Finance,* 54, 1869-1884.

Ho T.S.Y., Lee S.B. (1986). Term structure movements and pricing interest contingent claims. Journal of Finance, 41, 1011-1029.

Hull J., White A. (1990). Pricing interest rate derivative securities. *Review of Financial Studies*, 3, 573-592.

Hull J., White A. (1994b). Numerical procedures for implementing term structure models 2: two factor models. *Journal of Derivatives*, 2, 37-49.

Hung-Gay, F. and Leung, W. K. (1993). The Pricing Relationship of Eurodollar Futures and Eurodollar Deposit Rates: Introduction. *The Journal of Futures Markets,* 13, 115-126.

Hutchison, D. (1995). Retail bank deposit pricing: An intertemporal asset pricing approach. *Journal of Money, Credit and Banking*, 27, 217-231.

Imbierowicz, B., & Rauch, C. (2012). The relationship between liquidity risk and credit risk in banks. SSRN Working Paper Series.

Ivashina V. (2005). Structure and pricing of syndicated loans. *The New York City Area Conference on Financial Intermediation. Working Paper.*

Jiangli, W., & Pritsker, M. (2008). The impacts of securitization on US bank holding companies. *Board of Governors of the Federal Reserve System, Working paper*.

Johnson. L. (1960). The theory of speculation in commodity futures, *Review of Economic Studies,* 27, 139-51.

Kiser, E. K. (2004). Modeling the Whole Firm: The Effect of Multiple Inputs and Financial Intermediation on Bank Deposit Rates, *FEDS Working Paper No. 2004-07, Federal Reserve Board.*

Koch T. W.(1995). Bank Management. 3rd Edition. The Dryden Press, Orlando, US

Kolb R., Gay G. (1982). Bank immunization with interest rate futures. *Proceedings of a conference on bank structure and competition, Federal Reserve Bank of Chicago.*

Kolb R. W., Timme S. G., Gay G.D. (1984). Macro versus Micro Futures Hedges at Commercial Banks. *The Journal of Futures Market*, 4, 47-54.

Koppenhaver G. (1985). Bank Funding Risks, Risk Aversion, and the Choice of Futures Hedging Instrument. *Journal of Finance*, 40, 241-255.

Koppenhaver G. (1990). An empirical Analysis of Bank Hedging in Futures market. *The Journal of Futures markets,* 10, 1-12.

Laeven, L. and Levine, R. (2007), Is there a diversification discount in financial conglomerates? *Journal of Financial Economics*, 85, 331-67.

Lepetit, L., Nys, E., Rous, P. and Tarazi, A. (2008), Bank income structure and risk: an empirical analysis of European Banks. *Journal of Banking and Finance*, 32 1452-67.

Lewent, J. C. and Kearney, A. J. (1990), Identifying, measuring, and hedging currency risk at Merck. *Journal of Applied Corporate Finance*, 2, 19–28.

Lown, C., Osler, C., Strahan, P., Sufi, A. (2000). The Changing Landscape of the Financial Services Industry: What Lies Ahead? *Federal Reserve Bank of New York,* 6(4), 39 – 55.

Mahieu, R. J., & Xu, Y. (2007). *Hedging with interest rate and credit derivatives by banks. Social Science Research Network.*

Maurer R., Valiani S. (2007). Hedging the exchange rate risk in international portfolio diversification: Currency forwards versus currency options. *Managerial Finance,* 33, 667 – 692

Meier G. (2011). Noninterest income: A diversification story or risky proposition? *MSc Finance thesis, University of Saskatchewan.*

Mengle D. (2007). Credit Derivatives: An Overview. *Economic Review-Federal Reserve Bank of Atlanta,* 92.4, 1-24.

Merton R.C. (1974). On the Pricing of Corporate Debt: The Risk Structure of Interest Rates. *Journal of Finance*, 29, 449-470.

Morgan G., Shome D., Smith S. (1988). Optimal Futures Position for Large Banking Firms. *Journal of Finance*, 43, 175-195.

Naceur, S. B. (2003). The Determinants of the Tunisian Banking Industry Profitability: Panel Evidence, Universite Libre de Tunis Working Papers.

Nelson, C. R., & Siegel, A. F. (1987). Parsimonious modeling of yield curves. *Journal of business*, 473-489.

Neumark D. and Sharpe S.A. (1992), Market Structure and the Nature of Price Rigidity: Evidence from the Market for Consumer Deposits. *The Quarterly Journal of Economics*, 107, 657-680.

Norden L. and Wagner W. (2008). Credit derivatives and loan pricing. *Journal of Banking and Finance,* 32, 2560-2569.

Panyagometh, K., Roberts, G., Gottesman, A., & Beyhaghi, M. (2013). Performance Pricing Covenants and Corporate Loan Spreads. *Working paper.*

Rogers, K.E., Sinkey Jr., J. F. (1999). An Analysis of Non-traditional Activities at U.S. Commercial Banks. *Review of Financial Economics*, 8, 25 – 39.

Samuelson, P. A. (1945). The effect of interest rate increases on the banking system. *The American Economic Review,* 16-27.

Scholnick, B. (1999). Interest rate asymmetries in long-term loan and deposit markets, *Journal of Financial Services Research*, 16, 5-26.

Smith, R., Staikouras, C. and Wood, G. (2003). Non-interest income and total income stability. Bank of England, London, Working paper.

Son Lai V. and Hassan M.K. (1997). An empirical investigation of assets-liability management of small US commercial banks. *Applied Financial Economics,* 7, 525-536.

Staikouras, C. and Wood G. (2003). The Determinants of Bank Profitability in Europe, Paper presented at the European Applied Business Research Conference.

Stiroh, K.J. (2004). Diversification in Banking: Is Noninterest Income the Answer? *Journal of Money, Credit and Banking*, 36, 853 – 882.

Stiroh, K.J. (2006). New Evidence on the Determinants of Bank Risk. *Journal of Financial Services Research,* 30, 237 – 263.

Stiroh, K. and Rumble, A. (2006). The dark side of diversification: the case of US financial holding companies. *Journal of Banking and Finance*, 30, 2131-61.

Strahan P.E. (1999). Borrower risk and the price and non price terms of bank loans. Working paper, Federal Reserve Bank of New York.

Tannous, G. (1991). Bank size, Transaction Costs, and Optimal Macrohedging with Financial Futures. *Pasific-Basin Capital Markest Research,* 2, 683-699.

Tuckman B. (2002). Fixed income securities: tools for today's market. 2nd Edition. John Wiley&Sons Inc., Hoboken, New Jersey.

Vasicek O. (1977). An equilibrium characterization of the term structure. *Journal of Financial Economics,* 5, 177-188.

Veit T., Reiff W. (1983). Commercial Banks and Interest Rate Futures: A hedging Survey. *The Journal of Futures markets*, 3, 283-293.

Vij, M. (2003). The new world of banking: A paradigm shift. *Journal of Management Research, 3*(3), 139-151.

Vindzanovic D., Momcilovic M., and Begovic S. (2011). Futures in function of the risk management. I International Symposium Engineering Management and Competitiveness 2011, Serbia

Williams B., Prather L. (2010). Bank risk and return: the impact of bank non-interest income. *International Journal of Managerial Finance*, 6, 220-244.

Working H. (1953). Futures Trading and Hedging. *The American Economic Review*, 43, 314-343.

APPENDIX A: TABLES

Table 1: Typical balance sheet structure

This table shows the typical structure of a balance sheet of a Canadian bank. Assets include cash, deposits with banks, securities, loans, and other assets. Liabilities include deposits, overnight funds, debt, and other liabilities. And shareholders' equity consists of retained earnings and common stock. Presented percentages of assets and liabilities are the approximate averages taken from six largest Canadian banks for the last three years (2010-2012); except for the variable and fixed rate loans, term deposits, and GICs. Banks report only overall dollar value of loans and deposits without separating them into variable rate and fixed rate. Most of assets and liabilities have maturities up to five years and we assume that each maturity is equally weighted. Banks used for analysis: Royal Bank of Canada, Toronto-Dominion Bank, Canadian Imperial Bank of Commerce, Bank of Montreal, Bank of Nova Scotia, and National Bank of Canada.

STRUCTURE OF THE ORDINARY BALANCE SHEET			
ASSETS		**LIABILITIES**	
Cash	**2%**	**Demand deposits**	**5%**
Deposits with banks	**2%**	**Savings deposits**	**10%**
Securities	**21%**	**Purchased overnight funds**	**4%**
1 month	0.18%	**Term deposits, fixed rate**	**15%**
2 months	0.18%	1 month	0.25%
...		2 months	0.25%
60 months	0.18%	...	
Installment loans, fixed rate	**15%**	60 months	0.25%
1 month	0.13%	**Term deposits, variable rate**	**30%**
2 months	0.13%	1 month	0.5%
...		2 months	0.5%
60 months	0.13%	...	
Installment loans, variable rate	**15%**	60 months	0.5%
1 month	0.25%	**Subordinated debt**	**1%**
...		**Other liabilities**	**15%**
60 months	0.25%		
Term loans, fixed rate	**15%**	**SHAREHOLDERS' EQUITY**	
1 month	0.25%	**Retained earnings**	**2%**
...		**Common stock**	**3%**
60 months	0.25%		
Term loans, variable rate	**15%**		
1 month	0.25%		
...			
60 months	0.25%		
Other asset	**15%**		
Total Assets	**100%**	**Total Liabilities**	**100%**

Table 2: Balance sheet variables used as control variable to generate various simulation scenarios

We assume that a typical Canadian bank holds approximately 60% of the assets in the form of variable and fixed rate loans and approximately 60% of funds are raised through variable and fixed rate deposits. Deposits include demand deposits, term deposits, and Guaranteed Investment Certificates (GICs). In the simulations, we allow fixed rate loans as a percentage of total loans to vary from 0% to 100% and variable rate loans will make up the remainder of loans. Similarly, we allow fixed rate deposits as a percentage of total deposits to vary from 0% to 100% and variable rate deposits we make up the balance.

Assets		**Liabilities**	
Asset class	**Percentage**	**Liability class**	**Percentage**
Loans	60%	Deposits	60%
Fixed rate loans as percentage of total loans	Varies from 0 to 100%	Fixed rate deposits as percentage of total deposits	Varies from 0 to 100%
Variable rate loans	100% – percentage of fixed rate loans	Variable rate deposits	100% – percentage of fixed rate deposits

Table 3: List of macroeconomic variables

We analyze sixteen macroeconomic variables that could potentially impact fee-based income in Canadian banks. This table presents names of the variables, description and source of data. We use all these macroeconomic variables to choose only few of variables that have significant impact on fee-based income.

Variable	Description	Source
short_i	Short term interest rates	IMF World Economic Outlook Database
long_i	Long term interest rates	IMF World Economic Outlook Database
bank_i	Bank interest rates	Bank of Canada
real_i	Real interest rates	World Bank Database
infl	Inflation	World Bank Database
gdppc	Gross Domestic Product per capita	Statistics Canada
gdp	Gross Domestic Product	Statistics Canada
tsx	Return on TSX-500 index	TSX–Canadian Financial Markets Research Center
mcap	Market capitalization	World Bank Database
fdi	Foreign Direct Investment Inflow to Canada	Statistics Canada
netFDI	Net Foreign Direct Investment	Statistics Canada
export	Exports	Statistics Canada
equity	Equity trading volume	TSX e-review
oil	Oil prices	Federal Reserve Economic Data
cpi	Consumer Price Index	Statistics Canada
unempl	Unemployment rate	Statistics Canada

Table 4: Sources of fee-based income

Fee-based income can be generated through traditional and non-traditional activities. Traditional services have been offered by banks for a long period of time and are related to intermediation activities of banks. Non-traditional services appeared in banks relatively recently, after the Bank Act of 1989. Non-traditional services can be basic and advanced. Basic services do not require high capital and expensive knowledge and could be offered by any bank. However, advanced services require economies of scale and could only be provided by large banks that have specialized knowledge.

Sources of Fee-based Income		
Traditional	**Non-traditional**	
	Basic	**Advanced**
Deposit and Payment Service Fees	*Securities Commissions and Brokerage Fees*	*Investment Management and Custodial Fees*
Lending Service Fees	*Insurance Premiums*	*Underwriting and Advisory Fees*
Card Fees	*Mutual Fund Revenues*	*Trading*
	Securitization Revenues	

Table 5: The percentage of net income from various sources of interest and fee-based income

This table shows percentage contributions of each income source towards net income. The sample is divided into two sub periods, before and after 2000, in order to see a change in percentage contributions over years.

Sources of net income in a bank		
	1990-1999	**2000-2011**
Net Interest Income	**62%**	**49%**
Interest Income		
-Interest Expense		
Fee-Based Income	**38%**	**51%**
Traditional fee-based income:		
Deposit and payment service	*7.1%*	*6.6%*
Lending	*4.5%*	*3.9%*
Card fees	*3.4%*	*2.6%*
	15%	***13%***
Basic non-traditional income:		
Securities commissions and fees	*7.0%*	*7.1%*
Insurance	*1.2%*	*3.6%*
Mutual fund	*1.9%*	*5.3%*
Securitization	*1.4%*	*3.4%*
	11%	***19%***
Advanced non-traditional income:		
Investment management and custodial fees	*2.4%*	*3.7%*
Underwriting and advisory fees	*6.6%*	*4.6%*
Trading	*4.4%*	*2.5%*
	13%	***11%***
Net Income	**100%**	**100%**

Table 6: Summary statistics for sources of fee-based income

Table presents a summary statistics of net income sources during 1990-2011. All numbers presented below are in $ millions.

SUMMARY STATISTICS FOR BANK INCOME SOURCES						
	Mean	**Std. Dev.**	**CV**	**Min**	**Max**	**Correlation with Net Interest Income**
Deposit and payment service	587	226	0.39	250	944	0.97
Lending	326	119	0.36	146	564	0.91
Card fees	249	87	0.35	122	395	0.97
Securities commissions	673	257	0.38	218	1024	0.55
Insurance	302	354	1.17	28	1146	0.91
Mutual fund	353	287	0.81	8	988	0.91
Securitization	281	176	0.62	26	641	0.95
Investment management	357	196	0.55	39	665	0.91
Underwriting and advisory	500	111	0.22	267	651	0.59
Trading	400	463	1.16	-1270	1029	-0.04
Securities gains	128	169	1.32	-273	381	-0.24
Other	343	185	0.54	118	766	0.66
Fee-based income	4288	2031	0.47	933	7946	0.88
Net interest income	4506	1615	0.36	2319	8014	1.00

Table 7: Correlations between net interest income and fee-based income sources

This table presents correlation between net interest income and fee-based income sources during 1990-2011.

	1990-2011
Sources of net income in a bank	**Correlation with net interest income**
Net Interest Income	1.00
Fee-Based Income	0.90
Traditional fee-based income:	
Deposit and payment service	0.97
Lending	0.91
Card fees	0.97
Basic non-traditional income:	
Securities commissions and brokerage fees	0.55
Insurance	0.91
Mutual fund	0.91
Securitization	0.95
Advanced non-traditional income:	
Investment management and custodial fees	0.91
Underwriting and advisory fees	0.59
Trading	-0.04
Securities Gains or Losses	-0.24
Other	0.66
Net Income	

Table 8: Correlation between net interest income and fee-based income for individual banks

This table presents separate correlations of net interest income and fee-based income for each of six largest Canadian banks. Left column of correlations presents a case when all components of fee-based income are included and right column presents correlations of fee-based revenues as if trading services were not provided. We find that trading income is very volatile and when we exclude it from fee-based income correlation of fee-based income and net interest income becomes stronger for most of the banks.

	Correlation of net interest income and fee-based income	
Bank	**All fee-based income**	**Excluding trading income**
BMO	0.956	0.949
CIBC	0.432	0.676
RBC	0.920	0.952
SCOTIABANK	0.973	0.970
TD	0.843	0.886
NBC	0.686	0.814

Table 9: Average correlations between the various components of fee-based income

This table presents average correlations between sources of fee-based income. We took a yearly average of income from the below sources across six Canadian banks (Royal Bank of Canada, Toronto-Dominion Bank, Canadian Imperial Bank of Commerce, Bank of Montreal, Bank of Nova Scotia, and National Bank of Canada) during 1990-2011and run a correlation analysis. Low or negative correlation coefficients mean that there is a diversification opportunity within fee-based income.

	Securities & Brokerage	**Deposit & Payment**	**Trading**	**Insurance**	**Investment management**	**Underwriting & Advisory**	**Securitization**	**Mutual Fund**	**Lending**	**Card**	**Securities gains**
Securities & Brokerage	1.00										
Deposit & Payment	0.66	1.00									
Trading	0.36	-0.01	1.00								
Insurance	0.28	0.83	0.02	1.00							
Investment Management	0.82	0.95	0.06	0.70	1.00						
Underwriting & Advisory	0.67	0.66	0.34	0.45	0.72	1.00					
Securitization	-0.09	0.88	-0.16	0.95	0.82	0.20	1.00				
Mutual Fund	0.64	0.94	-0.02	0.75	0.93	0.67	0.70	1.00			
Lending	0.69	0.87	0.17	0.81	0.91	0.61	0.89	0.81	1.00		
Card	0.61	0.98	-0.09	0.85	0.92	0.63	0.90	0.91	0.89	1.00	
Securities gains	0.34	-0.23	0.54	-0.21	-0.06	0.29	-0.46	0.02	0.03	-0.23	1.00
Other	0.66	0.74	-0.25	0.39	0.81	0.55	0.17	0.86	0.61	0.70	0.14

Table 10: Summary statistics for macroeconomic variables

Table presents a summary statistics of macroeconomic variables during 1990-2011. All numbers presented below are in $ millions, except interest rates, inflation and unemployment rate, return on TSX-500, oil price and Consumer Price Index. Definitions of the macroeconomic variables can be found in Table 3.

Variable	Average	Std.Dev	Min	Max	Skewness	Kurtosis
short_i	4.2916	2.8044	12.8083	0.3500	1.3300	3.0115
long_i	6.1242	2.1237	10.8517	3.2142	0.6926	-0.4203
bank_i	4.6076	2.7892	13.0450	0.6458	1.3032	2.9648
real_i	4.0011	2.5868	10.5524	-0.3305	0.4954	0.6567
inflation	2.1733	1.2040	5.6152	0.1853	1.2602	3.0457
gdppc	34811	4096	39876	28778	-0.25	-1.63
gdp	1121112	346881	1720748	679921	0.28	-1.36
tsx	6.6628	17.6624	30.6909	-35.0274	-0.5615	-0.2018
mcap	930234	643681	2186550	242000	0.7876	-0.6854
fdi	322307	160542	607497	130932	0.3492	-1.2634
netFDI	302169	148762	574147	125265	0.3655	-1.2246
export	403112	99984	510105	219313	-0.7540	-0.9259
equity	49471	37470	118526	5660	0.5900	-1.0672
oil	40.1518	27.0450	99.6700	14.4200	1.0702	-0.1919
cpi	98.2928	12.5032	119.8583	78.3583	0.1972	-1.2815
unemploy	8.2227	1.5946	11.4000	6.0000	0.5991	-0.5589

Table 11: Correlations between fee-based income sources and macroeconomic variables

This table presents correlation coefficients between fee-based income sources and macroeconomic variables. Definition of macroeconomic variables is presented in Table 3. High correlation coefficient signals that macroeconomic factor has a significant relationship with income and could be used to model that income in our model.

	Deposit service	Lending fees	Card fees	Securities commissions	Insurance	Mutual fund	Securitization	Investment management	Underwriting	Trading	Securities Gains	Other	Total fee-based income
short_i	-0.82	-0.79	-0.82	-0.62	-0.67	-0.70	-0.78	-0.80	-0.66	0.03	0.28	-0.53	-0.76
long_i	-0.93	-0.89	-0.92	-0.80	-0.69	-0.88	-0.85	-0.95	-0.80	-0.07	-0.03	-0.78	-0.93
bank_i	-0.81	-0.79	-0.81	-0.62	-0.67	-0.69	-0.76	-0.79	-0.67	-0.02	0.25	-0.51	-0.76
real_i	-0.78	-0.65	-0.77	-0.67	-0.48	-0.80	-0.31	-0.78	-0.58	0.03	0.02	-0.66	-0.74
infl	-0.24	-0.27	-0.25	-0.23	-0.22	-0.09	-0.11	-0.23	0.25	0.13	0.30	-0.05	-0.18
gdppc	0.94	0.83	0.90	0.82	0.64	0.93	0.65	0.97	0.76	0.11	-0.02	0.82	0.96
gdp	0.99	0.85	0.97	0.66	0.80	0.97	0.83	0.95	0.69	-0.02	-0.13	0.80	0.95
tsx	-0.02	0.03	0.01	0.08	0.08	-0.17	-0.03	-0.09	0.07	0.45	0.12	-0.31	0.06
mcap	0.90	0.77	0.86	0.57	0.81	0.89	0.70	0.83	0.72	0.23	0.10	0.68	0.92
fdi	0.99	0.87	0.97	0.64	0.83	0.96	0.89	0.95	0.65	-0.02	-0.18	0.77	0.94
NetFDI	0.99	0.87	0.96	0.63	0.83	0.96	0.89	0.95	0.65	-0.03	-0.18	0.77	0.94
export	0.80	0.78	0.76	0.94	0.41	0.79	0.09	0.92	0.76	0.24	0.21	0.80	0.87
equity	0.98	0.81	0.97	0.55	0.84	0.92	0.86	0.89	0.59	-0.12	-0.29	0.73	0.89
oil	0.87	0.65	0.87	0.39	0.77	0.92	0.75	0.77	0.49	-0.26	-0.18	0.76	0.77
cpi	0.99	0.86	0.97	0.67	0.81	0.96	0.85	0.95	0.70	-0.01	-0.16	0.77	0.95
unemploy	-0.70	-0.64	-0.66	-0.79	-0.33	-0.74	-0.07	-0.80	-0.67	-0.13	-0.19	-0.80	-0.77

Table 12: Correlation between fee-based income and interest rates.

This table shows two sub samples of correlation between fee-based income and interest rates, before and after 2000. Short_i stands for short term interest rates and long_i stands for long-term interest rates.

	Deposit service	Lending fees	Card fees	Securities commissions	Insurance	Mutual fund	Securitization	Investment management	Underwriting	Trading	Securities Gains	Other	Total fee-based income
1990-1999													
short_i	-0.83	-0.61	-0.76	-0.59	-0.63	-0.68	0.87	-0.65	-0.80	-0.39	-0.67	-0.57	-0.73
long_i	-0.94	-0.91	-0.91	-0.85	-0.79	-0.93	-0.74	-0.90	-0.86	-0.58	-0.98	-0.90	-0.95
2000-2011													
short_i	-0.78	-0.68	-0.78	0.64	-0.81	-0.42	-0.79	-0.66	-0.26	0.30	0.51	0.13	-0.42
long_i	-0.95	-0.58	-0.93	0.60	-0.84	-0.86	-0.80	-0.85	-0.37	0.35	0.18	-0.39	-0.68

Table 13: Securities commissions and brokerage fees regressions

We use the following regression model to test a relationship between fee-based income sources and macroeconomic variables: *Source of fee-based income*$_k$ = β_0 + β_1**Macroeconomic factor*$_j$, where k=1,…,6 represents six Canadian banks, and j=1,…16 represents different macroeconomic factors. Description of macroeconomic factors is given in Table 3. We run regressions for every bank and the table below presents the average results across all banks' regressions of that fee-based income source. Mean represents average coefficients of β_0, β_1 and their average standard errors (se0 and se1) with average adjusted R-squared (adj.R2). Standard deviation column (Std.Dev) represents standard deviations of those coefficients across six banks' regressions (Royal Bank of Canada, Toronto-Dominion Bank, Canadian Imperial Bank of Commerce, Bank of Montreal, Bank of Nova Scotia, and National Bank of Canada) during 1990-2012. We use these regressions to choose few macroeconomic variables that have the most significant explanatory power and therefore, can be used in our spreadsheet Monte-Carlo model to simulate fee-based income sources.

Regression of securities commissions and brokerage fees on macroeconomic variables										
	Mean					Std.Dev				
	β0	se0	β1	se1	adj. R2	β0	se0	β1	se1	adj. R2
short_i	791.3655	81.5082	-19.8615	25.8357	-0.0966	371.2972	34.1711	15.0849	6.0777	0.1817
long_i	1181.9882	201.0802	-101.3394	44.5810	0.3497	495.3427	67.0677	50.5461	19.7691	0.2667
real_i	785.3917	60.4579	-20.2153	17.9064	0.1334	343.2190	46.5126	28.0066	10.5679	0.1546
infl	686.6573	104.3897	22.7270	47.2979	0.1302	432.7623	42.0976	67.7517	16.7885	0.1877
log_gdppc	-18014.4269	11898.4703	1778.0164	1127.1046	0.1892	10532.7658	9072.2095	1025.1635	856.2637	0.3287
log_gdp	-9575.2724	3735.0900	725.9547	263.5046	0.4474	6785.8147	2323.9086	471.8211	161.7723	0.3138
tsx	733.6213	45.3984	-0.7331	2.2738	-0.0855	351.6614	20.5978	1.2436	1.1997	0.1528
log_mcap	-1156.6961	1337.0320	134.9491	94.9256	0.1116	802.2546	568.2825	75.8744	39.3188	0.3044
log_fdi	-5417.0934	2814.3452	470.0869	215.0702	0.3425	4470.9371	2310.3075	332.5394	173.2631	0.2562
log_netfdi	-5332.2821	2518.2813	466.0526	193.7027	0.3713	4394.2149	1783.3186	328.1352	134.1337	0.2549
log_export	-5318.1243	5941.7542	465.5768	455.5318	0.0558	7516.7401	2645.4560	570.0530	201.7434	0.3581
equity_log	654.9039	2195.0513	12.3106	192.0191	0.2551	3330.2112	2696.0567	316.9013	231.4700	0.3939
oil	585.4213	115.6050	2.1309	1.7414	0.2078	297.0810	67.5231	2.0744	0.9318	0.3783
cpi	-619.3014	617.3969	12.2042	5.6211	0.3498	779.0135	331.1154	6.7614	2.7983	0.2928
unempl	1142.8693	313.9436	-53.9591	42.2870	-0.0205	611.2272	73.1232	54.9486	10.1434	0.2739

Table 14: Deposit and service fees regressions

We use the following regression model to test a relationship between fee-based income sources and macroeconomic variables: *Source of fee-based income*$_k$ = β_0 + β_1**Macroeconomic factor*$_j$, where k=1,…,6 represents six Canadian banks, and j=1,…16 represents different macroeconomic factors. Description of macroeconomic factors is given in Table 3. We run regressions for every bank and the table below presents the average results across all banks' regressions of that fee-based income source. Mean represents average coefficients of β_0, β_1 and their average standard errors (se0 and se1) with average adjusted R-squared (adj.R2). Standard deviation column (Std.Dev) represents standard deviations of those coefficients across six banks' regressions (Royal Bank of Canada, Toronto-Dominion Bank, Canadian Imperial Bank of Commerce, Bank of Montreal, Bank of Nova Scotia, and National Bank of Canada) during 1990-2012. We use these regressions to choose few macroeconomic variables that have the most significant explanatory power and therefore, can be used in our spreadsheet Monte-Carlo model to simulate fee-based income sources.

Regression of deposit and service fees on macroeconomic variables										
	Mean					Standard Deviation				
	β0	se0	β1	se1	adj. R2	β0	se0	β1	se1	adj. R2
short_i	875.1354	60.0130	-67.1040	12.2371	0.6020	372.3535	42.0968	40.7866	8.1389	0.0609
long_i	1189.4881	73.1488	-98.2605	11.4463	0.8054	548.5028	61.3526	60.3760	9.4126	0.0805
real_i	828.2467	63.2460	-63.6013	13.7000	0.5361	350.3467	43.9184	38.0068	9.1530	0.0765
infl	656.0664	106.0504	-26.4939	44.1816	0.0184	280.2566	69.4539	52.0056	27.8163	0.0416
log_gdppc	-17486.2992	1932.2645	1729.6304	184.8415	0.8452	11046.5655	1822.5265	1070.9120	174.4031	0.0863
log_gdp	-9060.7299	738.3585	695.1419	53.1418	0.9082	6270.9710	603.8408	461.3858	43.4982	0.0434
tsx	600.4809	53.9633	-0.6822	2.9031	-0.0432	247.4203	36.8101	0.6949	1.9989	0.0114
log_mcap	-3207.0998	443.4226	281.2733	32.7505	0.7975	2383.6376	319.7813	185.9944	23.6746	0.0444
log_fdi	-4505.2432	408.7781	405.8905	32.5122	0.9022	3211.3801	355.0510	266.3487	28.2760	0.0481
log_netfdi	-4573.0175	413.4569	413.2853	33.0444	0.9018	3265.0252	355.7751	271.9264	28.4714	0.0468
log_export	-7553.0129	1565.5133	632.3963	121.4966	0.6153	4123.5755	1287.0624	332.5639	100.0030	0.1475
equity_log	-1778.4767	225.7190	226.4243	21.4614	0.8677	1336.7305	191.7926	140.2981	18.3100	0.0640
oil	306.9855	47.0527	7.1419	0.9712	0.6726	233.9978	25.1014	5.5380	0.5254	0.1302
cpi	-1137.4266	123.1314	17.5797	1.2389	0.9083	1071.5518	83.7519	12.0658	0.8468	0.0518
unemploy	1384.6562	200.1518	-96.3545	23.9948	0.4761	631.7408	157.5118	53.9674	18.7707	0.1015

Table 15: Trading revenue regressions

We use the following regression model to test a relationship between fee-based income sources and macroeconomic variables: *Source of fee-based income*$_k$ = β_0 + β_1**Macroeconomic factor*$_j$, where k=1,…,6 represents six Canadian banks, and j=1,…16 represents different macroeconomic factors. Description of macroeconomic factors is given in Table 3. We run regressions for every bank and the table below presents the average results across all banks' regressions of that fee-based income source. Mean represents average coefficients of β_0, β_1 and their average standard errors (se0 and se1) with average adjusted R-squared (adj.R2). Standard deviation column (Std.Dev) represents standard deviations of those coefficients across six banks' regressions (Royal Bank of Canada, Toronto-Dominion Bank, Canadian Imperial Bank of Commerce, Bank of Montreal, Bank of Nova Scotia, and National Bank of Canada) during 1990-2012. We use these regressions to choose few macroeconomic variables that have the most significant explanatory power and therefore, can be used in our spreadsheet Monte-Carlo model to simulate fee-based income sources.

Regression of trading revenue on macroeconomic variables										
	Mean					Standard Deviation				
	β0	se0	β1	se1	adj. R2	β0	se0	β1	se1	adj. R2
short_i	322.7574	355.0144	29.2037	99.5127	0.1460	745.2773	401.9027	155.1831	121.5747	0.2370
long_i	135.0773	727.2921	61.8854	139.8029	0.1178	1860.8786	954.9717	322.0256	195.0229	0.1988
real_i	356.5934	316.9024	20.2095	86.9673	0.0324	736.9470	335.5387	139.6692	98.6125	0.0755
infl	244.3970	506.1827	81.0565	243.1472	-0.0187	203.3477	583.6136	195.4470	274.4266	0.0830
log_gdppc	2601.7239	21081.8365	-205.1396	2006.2995	0.0940	41843.7046	28710.8171	4006.0244	2727.8919	0.2013
log_gdp	3456.0005	9359.9320	-215.3998	667.6627	0.1145	21406.4088	11697.6349	1542.0820	831.7119	0.2185
tsx	302.9296	162.2117	13.7083	8.4836	0.0472	434.3100	151.4339	23.6944	7.9461	0.1310
log_mcap	-2206.2047	4160.2928	190.2403	300.8556	0.1009	2932.3199	5466.1138	237.5358	392.5368	0.2728
log_fdi	1784.6737	5223.5683	-105.0408	408.2339	0.1183	11584.2944	6772.0397	922.2860	526.0731	0.2301
log_netfdi	1771.5437	5215.7056	-104.6451	409.7773	0.1170	11534.6345	6708.9178	923.2894	523.9577	0.2281
log_export	-6711.7633	18868.1725	549.3358	1448.6823	0.0623	13451.9448	29475.4722	1060.7259	2258.7182	0.1626
equity_log	1730.3751	2848.7403	-118.4618	261.3372	0.1208	7073.8110	3640.2321	666.8654	330.4001	0.2215
oil	677.5448	296.2679	-5.6216	5.4933	0.1054	659.9863	314.3900	15.8570	5.5273	0.1268
cpi	977.1421	1613.8683	-5.3191	15.5670	0.1193	3332.9631	1961.7517	34.1834	18.6194	0.2294
unemploy	221.5875	1194.8483	29.9166	157.1579	0.0336	2646.2522	1588.2019	317.0883	216.1587	0.1322

Table 16: Insurance revenue regressions

We use the following regression model to test a relationship between fee-based income sources and macroeconomic variables: *Source of fee-based income*$_k$ = β_0 + β_1**Macroeconomic factor*$_j$, where k=1,…,6 represents six Canadian banks, and j=1,…16 represents different macroeconomic factors. Description of macroeconomic factors is given in Table 3. We run regressions for every bank and the table below presents the average results across all banks' regressions of that fee-based income source. Mean represents average coefficients of β_0, β_1 and their average standard errors (se0 and se1) with average adjusted R-squared (adj.R2). Standard deviation column (Std.Dev) represents standard deviations of those coefficients across six banks' regressions (Royal Bank of Canada, Toronto-Dominion Bank, Canadian Imperial Bank of Commerce, Bank of Montreal, Bank of Nova Scotia, and National Bank of Canada) during 1990-2012. We use these regressions to choose few macroeconomic variables that have the most significant explanatory power and therefore, can be used in our spreadsheet Monte-Carlo model to simulate fee-based income sources.

Regression of insurance revenue on macroeconomic variables										
	Mean					Standard Deviation				
	β0	se0	β1	se1	adj. R2	β0	se0	β1	se1	adj. R2
short_i	996.0238	196.8158	-126.7674	39.1625	0.3745	1286.1457	303.3702	162.3700	48.5992	0.1637
long_i	1991.6980	225.9701	-248.3063	33.5287	0.8382	2556.9242	359.9903	294.9087	46.6485	0.0845
real_i	892.7181	251.8910	-111.4173	49.3978	0.1636	1235.7607	437.5962	172.8921	73.0416	0.1800
infl	565.0695	309.2777	-46.7644	123.6372	-0.0110	685.7666	440.6330	116.3630	161.2959	0.0945
log_gdppc	-48729.9740	5428.5808	4716.9077	519.1653	0.7138	66300.0103	5031.2973	6436.5197	484.7897	0.1950
log_gdp	-21585.4437	1626.6654	1591.6807	117.4295	0.8758	29806.0524	2172.4169	2204.1476	158.3235	0.1312
tsx	444.3329	178.4636	1.6914	9.8834	-0.0816	438.4200	310.2759	4.7317	17.4473	0.0204
log_mcap	-8233.6196	1032.4801	648.0623	76.5303	0.7537	11790.7768	1252.2544	930.1013	94.8252	0.0987
log_fdi	-11479.7265	939.2584	955.3125	74.7428	0.8419	15335.5473	987.8899	1287.0150	80.2692	0.1414
log_netfdi	-11566.4499	957.0492	966.9400	76.4653	0.8293	15596.5111	974.6456	1313.9535	79.5143	0.1422
log_export	-18151.6246	8098.1951	1461.0375	629.2077	0.2547	33054.7114	8063.8103	2637.8781	632.5473	0.2597
equity_log	-4961.7741	726.4109	521.5295	70.3621	0.8252	6080.8400	1052.3785	653.6458	105.1978	0.1061
oil	-225.4534	76.5138	17.4671	1.5656	0.7722	586.2349	97.7477	29.1545	2.1999	0.1659
cpi	-3199.6463	269.6800	37.5724	2.7376	0.8675	4554.3867	341.1235	53.6642	3.6250	0.1258
unemploy	2814.4537	894.9733	-260.0520	101.5974	0.1786	4816.4697	1365.7209	462.6602	142.6914	0.2508

Table 17: Investment management revenue regressions

We use the following regression model to test a relationship between fee-based income sources and macroeconomic variables: $Source\ of\ fee\text{-}based\ income_k = \beta_0 + \beta_1 * Macroeconomic\ factor_j$, where k=1,…,6 represents six Canadian banks, and j=1,…16 represents different macroeconomic factors. Description of macroeconomic factors is given in Table 3. We run regressions for every bank and the table below presents the average results across all banks' regressions of that fee-based income source. Mean represents average coefficients of β_0, β_1 and their average standard errors (se0 and se1) with average adjusted R-squared (adj.R2). Standard deviation column (Std.Dev) represents standard deviations of those coefficients across six banks' regressions (Royal Bank of Canada, Toronto-Dominion Bank, Canadian Imperial Bank of Commerce, Bank of Montreal, Bank of Nova Scotia, and National Bank of Canada) during 1990-2012. We use these regressions to choose few macroeconomic variables that have the most significant explanatory power and therefore, can be used in our spreadsheet Monte-Carlo model to simulate fee-based income sources.

Regression of investment management revenue on macroeconomic variables										
						Standard Deviation				
	β0	se0	β1	se1	adj. R2	β0	se0	β1	se1	adj. R2
short_i	560.1133	53.5603	-48.1112	11.2622	0.2621	614.3837	64.8520	71.8481	12.3812	0.3260
long_i	835.3843	66.1495	-80.4225	11.2189	0.5597	983.1651	65.0703	109.7934	9.6449	0.2548
real_i	524.1952	51.5282	-46.0310	11.3144	0.1687	582.9651	64.2115	75.1843	13.3788	0.3654
infl	410.5626	87.8255	-21.9844	36.1363	0.1216	383.4067	115.7950	45.7125	46.4624	0.1410
log_gdppc	-14876.8292	1958.9232	1456.2303	186.6617	0.4796	21286.4865	1269.5758	2066.0282	121.0763	0.4048
log_gdp	-7519.7117	718.3840	566.2417	51.3032	0.5705	11023.7047	279.6955	816.1243	19.9678	0.3126
tsx	367.2894	44.0227	-1.2475	2.3760	0.0027	323.3756	59.6622	2.1304	3.2344	0.0746
log_mcap	-2601.6409	424.7139	218.6841	31.0872	0.4129	4171.7928	366.8307	331.1974	27.2901	0.4239
log_fdi	-3821.2812	379.8399	331.7742	29.7569	0.5271	5751.3746	148.4806	482.4288	11.5263	0.3826
log_netfdi	-3867.9974	368.2286	337.1493	29.0170	0.5321	5848.8253	133.8628	492.5440	10.5225	0.3709
log_export	-6518.8976	1344.0801	533.4992	104.0666	0.3877	9175.7683	1396.7340	736.4828	108.6299	0.3676
equity_log	-1459.9187	282.1578	173.2630	26.0039	0.4458	2410.2040	186.4401	259.4296	17.1674	0.4648
oil	131.7604	46.7861	5.4628	0.9157	0.3911	97.5209	43.4154	8.6834	0.9296	0.2424
cpi	-1004.9661	132.5601	13.7471	1.2923	0.5163	1731.8945	57.9050	20.6933	0.5936	0.3376
unemploy	1071.4421	157.5874	-87.9431	19.2556	0.2883	1327.9325	191.1141	124.7341	22.6803	0.3273

Table 18: Underwriting and advisory revenue regression

We use the following regression model to test a relationship between fee-based income sources and macroeconomic variables: *Source of fee-based income*$_k$ = β_0 + β_1**Macroeconomic factor*$_j$, where k=1,…,6 represents six Canadian banks, and j=1,…16 represents different macroeconomic factors. Description of macroeconomic factors is given in Table 3. We run regressions for every bank and the table below presents the average results across all banks' regressions of that fee-based income source. Mean represents average coefficients of β_0, β_1 and their average standard errors (se0 and se1) with average adjusted R-squared (adj.R2). Standard deviation column (Std.Dev) represents standard deviations of those coefficients across six banks' regressions (Royal Bank of Canada, Toronto-Dominion Bank, Canadian Imperial Bank of Commerce, Bank of Montreal, Bank of Nova Scotia, and National Bank of Canada) during 1990-2012. We use these regressions to choose few macroeconomic variables that have the most significant explanatory power and therefore, can be used in our spreadsheet Monte-Carlo model to simulate fee-based income sources.

Regression of underwriting and advisory fees on macroeconomic variables										
	Mean					Standard Deviation				
	β0	se0	β1	se1	adj. R2	β0	se0	β1	se1	adj. R2
short_i	563.6116	64.7705	-12.5073	22.7735	0.2521	320.2257	41.6580	46.4396	15.8597	0.2388
long_i	777.6894	195.7675	-56.9281	45.2371	0.3603	735.1419	85.6548	126.2527	21.9894	0.2484
real_i	515.9157	58.9252	3.2764	21.0400	-0.0141	265.7764	20.5109	18.0558	8.8786	0.1429
infl	523.0868	114.9232	4.7623	53.6597	-0.0928	243.4925	60.2724	49.3418	27.7412	0.1337
log_gdppc	-9935.4417	12748.1806	991.8196	1206.9243	0.1584	25309.1382	9828.5060	2412.7474	929.2525	0.3225
log_gdp	-3402.7899	4271.2232	277.7977	300.5562	0.2721	9287.3031	2707.0382	666.5694	189.1733	0.3340
tsx	530.5685	39.6512	0.5821	1.9602	-0.0435	299.1363	22.1848	1.2218	1.0742	0.2207
log_mcap	-1721.8486	1056.1985	158.6901	74.6067	0.3492	2950.5949	530.9160	218.5293	37.2253	0.4236
log_fdi	-1629.1772	2497.4896	166.2461	190.7542	0.2594	5357.6573	1416.4867	421.1466	106.7822	0.2703
log_netfdi	-1655.6081	2408.5108	169.1461	184.9880	0.2436	5129.5569	1321.1310	406.5494	100.1248	0.2780
log_export	1020.1010	7108.0765	-37.0921	544.1424	0.0132	6461.6479	4495.9070	493.2092	343.6490	0.1223
equity_log	-476.2747	1812.1598	89.5794	158.7792	0.1576	2316.7919	1321.1898	215.6561	113.5818	0.3256
oil	491.7894	108.2358	0.7109	1.5392	0.2061	251.8514	61.1142	3.4023	0.7592	0.2751
cpi	-191.3600	588.7721	6.5738	5.2929	0.3502	1424.0656	337.2962	14.2175	2.9247	0.2640
unemploy	505.8920	322.4541	3.9283	44.6284	0.0533	380.1043	195.2254	37.3925	27.3949	0.2148

Table 19: Securitization revenue regression

We use the following regression model to test a relationship between fee-based income sources and macroeconomic variables: $Source\ of\ fee\text{-}based\ income_k = \beta_0 + \beta_1 * Macroeconomic\ factor_j$, where k=1,…,6 represents six Canadian banks, and j=1,…16 represents different macroeconomic factors. Description of macroeconomic factors is given in Table 3. We run regressions for every bank and the table below presents the average results across all banks' regressions of that fee-based income source. Mean represents average coefficients of β_0, β_1 and their average standard errors (se0 and se1) with average adjusted R-squared (adj.R2). Standard deviation column (Std.Dev) represents standard deviations of those coefficients across six banks' regressions (Royal Bank of Canada, Toronto-Dominion Bank, Canadian Imperial Bank of Commerce, Bank of Montreal, Bank of Nova Scotia, and National Bank of Canada) during 1990-2012. We use these regressions to choose few macroeconomic variables that have the most significant explanatory power and therefore, can be used in our spreadsheet Monte-Carlo model to simulate fee-based income sources.

Regression of securitization revenue on macroeconomic variables										
	Mean					Standard Deviation				
	β0	se0	β1	se1	adj. R2	β0	se0	β1	se1	adj. R2
short_i	549.3338	82.9855	-87.2919	24.8180	0.4421	235.0265	39.0550	48.2338	11.6886	0.1900
long_i	1035.2047	188.8622	-154.6102	38.5935	0.4849	579.2304	89.9651	100.8900	18.4414	0.3059
real_i	328.6014	82.3118	-22.4016	23.9923	0.0792	125.1311	43.8923	19.1762	12.8118	0.1667
infl	363.9093	163.6257	-36.5139	76.7577	-0.0172	244.4530	74.0058	98.8662	34.8065	0.0919
log_gdppc	-16839.2167	7505.4414	1627.3453	712.9717	0.3139	9931.3142	4668.9893	952.0690	443.3815	0.3073
log_gdp	-8880.0643	2538.2597	651.9272	180.4088	0.4757	5237.9767	1478.1849	379.1167	105.0206	0.3187
tsx	290.4379	56.0939	-0.1144	2.9108	-0.0531	103.7340	27.1224	2.0823	1.4074	0.0234
log_mcap	-3064.6068	1198.9436	240.9951	86.0864	0.3559	2001.7995	664.2891	150.5259	47.6807	0.2919
log_fdi	-5298.4530	1443.7754	434.0313	112.0644	0.5139	2909.6141	854.0647	233.3597	66.2241	0.3012
log_netfdi	-5221.1710	1435.4824	430.3243	112.0157	0.5115	2828.9025	857.0102	228.3639	66.8061	0.3000
log_export	2600.7778	8739.6184	-176.7924	669.6022	0.0335	14031.0697	4260.1917	1073.6156	326.2901	0.0732
equity_log	-2604.3924	800.2958	262.8986	72.6000	0.4709	1552.0714	428.5546	149.4767	38.8504	0.2874
oil	67.4000	81.5879	4.4248	1.4207	0.3706	68.8831	42.9019	2.9733	0.7417	0.2866
cpi	-1307.0053	401.1403	15.1916	3.7994	0.5142	833.1498	224.8267	8.8174	2.1262	0.3160
unemploy	173.4613	480.9251	16.2762	65.5258	0.0088	631.0316	232.1820	85.8175	31.7352	0.0782

Table 20: Mutual fund fees regression

We use the following regression model to test a relationship between fee-based income sources and macroeconomic variables: $Source\ of\ fee\text{-}based\ income_k = \beta_0 + \beta_1 * Macroeconomic\ factor_j$, where k=1,…,6 represents six Canadian banks, and j=1,…16 represents different macroeconomic factors. Description of macroeconomic factors is given in Table 3. We run regressions for every bank and the table below presents the average results across all banks' regressions of that fee-based income source. Mean represents average coefficients of β_0, β_1 and their average standard errors (se0 and se1) with average adjusted R-squared (adj.R2). Standard deviation column (Std.Dev) represents standard deviations of those coefficients across six banks' regressions (Royal Bank of Canada, Toronto-Dominion Bank, Canadian Imperial Bank of Commerce, Bank of Montreal, Bank of Nova Scotia, and National Bank of Canada) during 1990-2012. We use these regressions to choose few macroeconomic variables that have the most significant explanatory power and therefore, can be used in our spreadsheet Monte-Carlo model to simulate fee-based income sources.

Regression of mutual fund fees on macroeconomic variables										
	Mean					Standard Deviation				
	β0	se0	β1	se1	adj. R2	β0	se0	β1	se1	adj. R2
short_i	722.9771	103.8335	-87.7015	24.5858	0.4131	298.3296	51.0869	26.6367	10.7101	0.1127
long_i	1218.3255	124.6067	-146.6275	21.1129	0.7215	546.4245	74.1835	65.2041	12.0801	0.1599
real_i	655.6420	78.2604	-80.6191	19.0241	0.4818	339.8934	36.8521	42.2185	8.2118	0.0767
infl	282.8506	163.4645	60.5190	74.4670	0.0042	203.5415	66.8781	57.0004	27.2359	0.0518
log_gdppc	-24354.9308	3104.2846	2362.8465	296.4864	0.7552	11729.1073	1912.3932	1137.9206	183.0738	0.1951
log_gdp	-12297.8564	1173.6021	910.6903	84.3211	0.8471	5399.0413	1038.5698	401.8827	74.8939	0.1754
tsx	425.6721	69.4481	-3.7829	3.6861	-0.0017	211.1262	33.2510	2.8373	1.8291	0.0260
log_mcap	-4560.7756	747.6132	363.7601	54.7892	0.7147	1941.2921	444.4699	157.3999	32.7315	0.1472
log_fdi	-6310.5945	713.0246	530.0541	56.4883	0.8104	2792.4830	552.7130	236.2960	44.1477	0.1740
log_netfdi	-6370.8788	717.7986	537.5437	57.1484	0.8120	2821.0281	555.0738	239.8718	44.5501	0.1705
log_export	-11990.2439	3464.2266	956.8441	267.2408	0.4214	6123.1253	2488.7817	486.1798	190.4423	0.1542
equity_log	-2976.1020	396.6925	316.2743	37.3248	0.7787	1146.1441	277.2242	125.0258	26.5641	0.2122
oil	12.6569	56.7703	9.0992	1.1374	0.7851	103.9535	35.8481	4.8293	0.7640	0.1020
cpi	-1835.2672	220.6359	22.2557	2.1984	0.8479	763.5467	188.7297	9.6233	1.9151	0.1539
unemploy	1469.6955	291.4811	-134.2582	36.3375	0.4190	796.3591	153.1254	74.8212	20.0709	0.1818

Table 21: Lending fees regression

We use the following regression model to test a relationship between fee-based income sources and macroeconomic variables: *Source of fee-based income*$_k$ = β_0 + β_1**Macroeconomic factor*$_j$, where k=1,…,6 represents six Canadian banks, and j=1,…16 represents different macroeconomic factors. Description of macroeconomic factors is given in Table 3. We run regressions for every bank and the table below presents the average results across all banks' regressions of that fee-based income source. Mean represents average coefficients of β_0, β_1 and their average standard errors (se0 and se1) with average adjusted R-squared (adj.R2). Standard deviation column (Std.Dev) represents standard deviations of those coefficients across six banks' regressions (Royal Bank of Canada, Toronto-Dominion Bank, Canadian Imperial Bank of Commerce, Bank of Montreal, Bank of Nova Scotia, and National Bank of Canada) during 1990-2012. We use these regressions to choose few macroeconomic variables that have the most significant explanatory power and therefore, can be used in our spreadsheet Monte-Carlo model to simulate fee-based income sources.

Regression of lending fees on macroeconomic variables										
	Mean					Standard Deviation				
	β0	se0	β1	se1	adj. R2	β0	se0	β1	se1	adj. R2
short_i	467.9964	39.7401	-33.6019	7.7929	0.4192	188.4767	12.4267	18.3837	2.4246	0.1950
long_i	628.9298	56.4771	-49.7081	8.7072	0.5485	268.0597	18.9649	27.2219	2.8872	0.2601
real_i	423.5513	43.2659	-28.0166	9.2015	0.2932	165.8431	14.3246	15.4190	3.0583	0.1665
infl	380.8170	62.4474	-26.0209	25.0964	0.0116	145.5316	25.1499	11.8767	10.0367	0.0456
log_gdppc	-8333.3993	1733.1031	828.3562	165.8116	0.5002	4976.6427	599.4745	484.0652	57.3398	0.2738
log_gdp	-4255.1131	809.9348	329.7804	58.3132	0.5371	2720.0140	256.8709	201.3642	18.4814	0.3064
tsx	323.1034	32.4452	0.1203	1.7594	-0.0341	121.8297	12.9521	0.7972	0.7041	0.0200
log_mcap	-1541.0708	360.7687	138.1367	26.6806	0.5096	995.5768	122.1786	79.3836	9.0301	0.2733
log_fdi	-2170.3764	410.5839	198.6532	32.6669	0.5604	1430.7568	131.3152	120.1899	10.4313	0.3146
log_netfdi	-2202.4725	417.0178	202.1767	33.3390	0.5588	1454.3895	131.9138	122.6395	10.5280	0.3149
log_export	-3928.0298	989.2919	330.3672	76.8529	0.4611	2065.7000	400.4818	168.1326	31.1279	0.2058
equity_log	-802.7867	206.2327	107.8135	19.6487	0.5265	570.6147	68.5066	62.1113	6.5119	0.2807
oil	202.3373	41.1804	2.9831	0.8509	0.3497	123.2068	14.4473	2.3732	0.3009	0.2683
cpi	-487.1599	145.3203	8.2422	1.4651	0.5316	452.1955	44.4901	5.2263	0.4470	0.3177
unemploy	711.6603	133.4207	-47.1198	15.9249	0.2782	317.1872	50.3804	26.4616	5.9998	0.1735

Table 22: Card fees regression

We use the following regression model to test a relationship between fee-based income sources and macroeconomic variables: *Source of fee-based income*$_k$ = β_0 + β_1**Macroeconomic factor*$_j$, where k=1,…,6 represents six Canadian banks, and j=1,…16 represents different macroeconomic factors. Description of macroeconomic factors is given in Table 3. We run regressions for every bank and the table below presents the average results across all banks' regressions of that fee-based income source. Mean represents average coefficients of β_0, β_1 and their average standard errors (se0 and se1) with average adjusted R-squared (adj.R2). Standard deviation column (Std.Dev) represents standard deviations of those coefficients across six banks' regressions (Royal Bank of Canada, Toronto-Dominion Bank, Canadian Imperial Bank of Commerce, Bank of Montreal, Bank of Nova Scotia, and National Bank of Canada) during 1990-2012. We use these regressions to choose few macroeconomic variables that have the most significant explanatory power and therefore, can be used in our Monte-Carlo model to simulate fee-based income sources.

Regression of card fees on macroeconomic variables										
	Mean					Standard Deviation				
	β0	se0	β1	se1	adj. R2	β0	se0	β1	se1	adj. R2
short_i	358.6572	36.2074	-25.6051	7.1111	0.2673	199.7264	23.0552	24.3601	4.5280	0.2659
long_i	480.8158	53.2976	-37.8896	8.2425	0.3441	314.6922	32.5774	37.1087	5.0381	0.3622
real_i	340.7415	34.8512	-24.7067	7.3666	0.2918	174.1684	22.6897	19.1353	4.7960	0.1834
infl	288.3390	52.9405	-18.2067	21.4228	0.0015	136.3465	37.9793	12.7057	15.3686	0.0560
log_gdppc	-6585.5198	1555.6858	653.9421	148.8471	0.3445	6564.3519	1014.2306	635.5824	97.0410	0.3433
log_gdp	-3466.6432	673.4430	267.6200	48.4960	0.4100	3851.7846	398.0210	282.6677	28.6623	0.4227
tsx	248.5314	27.3681	0.0359	1.4795	-0.0262	112.2820	19.4529	1.0366	1.0516	0.0236
log_mcap	-1223.3497	314.9137	109.0449	23.2941	0.3520	1463.8338	187.2885	113.7829	13.8537	0.3830
log_fdi	-1701.3728	370.3471	155.3495	29.4765	0.3973	1978.6223	216.7924	163.3407	17.2548	0.4077
log_netfdi	-1725.2322	374.9321	158.0109	29.9865	0.3979	2014.1703	218.0158	166.9605	17.4365	0.4078
log_export	-2780.1855	961.6836	235.3171	74.6950	0.2465	2296.1730	692.5323	185.2454	53.7898	0.2142
equity_log	-651.3924	181.5341	86.1560	17.3055	0.3796	814.9910	114.3062	84.9858	10.8967	0.3817
oil	135.4688	28.1592	2.8218	0.5858	0.4077	122.5563	13.9153	3.5820	0.2895	0.3921
cpi	-419.6702	113.3639	6.8005	1.1445	0.4331	668.5215	64.0514	7.4716	0.6467	0.4438
unemploy	548.0983	117.8763	-36.4025	14.0848	0.1658	353.9860	82.3330	31.6845	9.8378	0.1838

Table 23: Aggregate fee-based income description

After we identify macroeconomic variables that have the highest explanatory power we try to create a model of fee-based income in our simulation through a regression of income sources on Gross Domestic Product (GDP) and oil price. Not all banks have started to offer various fee-based services at the same time, and therefore, in order to be consistent we exclude earlier years and banks that do not report enough information from our analysis. And in order to increase our sample we add income from 2012 as well. We collect the aggregate data across six banks (Royal Bank of Canada, Toronto-Dominion Bank, Canadian Imperial Bank of Commerce, Bank of Montreal, Bank of Nova Scotia, and National Bank of Canada). We also combine deposit and payment service income, lending and card income into one category-traditional fee-based income. As we find no significant relationship between trading and securities gains or losses and macroeconomic variables, we do not link these incomes to macroeconomic factors in our model.

Fee-based Income	Years covered	Banks included
Traditional	1990-2012	RBC, TD, BMO, CIBC, Scotia, NBC
Securities comissions and brokerage	1998-2012	TD, BMO, CIBC
Insurance	2001-2012	TD, BMO, CIBC, NBC
Investment management	1997-2012	RBC, BMO, CIBC, Scotia
Underwriting and advisory	2000-2012	BMO, CIBC, Scotia
Securitization	1998-2012	RBC, TD, BMO, CIBC, Scotia, NBC
Mutual fund	1997-2012	RBC, TD, BMO, CIBC, Scotia, NBC

Table 24: Regression results for aggregate fee-based income

This table presents coefficients of regressions of aggregate data of six Canadian banks (Royal Bank of Canada, Toronto-Dominion Bank, Canadian Imperial Bank of Commerce, Bank of Montreal, Bank of Nova Scotia, and National Bank of Canada) on macroeconomic variables that we have already identified for each income source through Tables 12-23. We use these results to simulate fee-based income in our spreadsheet Monte-Carlo model. (Note: Standard deviations are presented in parentheses.)

AGGREGATE FEE-BASED INCOME REGRESSIONS				
	Constant	Coefficient	Macroeconomic variable	Adj R-Squared
Traditional fee-based income:	-1810.6470	0.0085	GDP	0.9500
	(512.6290)	(0.0004)		
Non-traditional fee-based income:				
Basic				
Securities comissions and fees	3278.6600	-0.0006	GDP	0.2530
	(349.6268)	(0.0002)		
Insurance	-1590.1060	0.0019	GDP	0.9566
	(190.1117)	(0.0001)		
Securitization revenue	-2615.9950	0.0031	Lagged GDP	0.6283
	(934.7453)	(0.0006)		
Mutual fund	-3856.131	0.0052	GDP	0.8900
	(647.8832)	(0.0005)		
Advanced				
Investment management fees	-933.1206	0.0022	GDP	0.9158
	(243.4807)	(0.0002)		
Underwriting and Advisory	600.9460	7.7953	Oil Price	0.8327
	(94.3204)	(2.8073)		

Table 25 : Summary statistics for Canadian yield curve.

This table presents a summary statistics for yields of Canadian zero-coupon bonds with maturity ranging from 3 month to 30 years during 1990-2012. The data is daily series.

Time to maturity	Obs	Mean	Std.Dev.	Min	Max	Skewness	Kurtosis
0.25	5669	0.04121	0.02752	0.00077	0.13566	1.13104	1.67295
0.5	5669	0.04183	0.02690	0.00173	0.13151	1.02869	1.35339
0.75	5669	0.04259	0.02654	0.00299	0.13197	0.94996	1.09225
1	5669	0.04338	0.02621	0.00427	0.13249	0.88733	0.88522
2	5669	0.04626	0.02501	0.00823	0.13027	0.72345	0.35913
3	5669	0.04849	0.02423	0.00932	0.12629	0.63094	0.07788
4	5669	0.05029	0.02371	0.01025	0.12335	0.57423	-0.07720
5	5669	0.05181	0.02329	0.01127	0.12142	0.53301	-0.17885
6	5669	0.05312	0.02291	0.01239	0.11981	0.50002	-0.27020
7	5669	0.05423	0.02259	0.01355	0.11807	0.47689	-0.36274
8	5669	0.05519	0.02233	0.01446	0.11621	0.46671	-0.44892
9	5669	0.05604	0.02216	0.01536	0.11448	0.46944	-0.51797
10	5669	0.05683	0.02206	0.01626	0.11318	0.48126	-0.56499
11	5669	0.05757	0.02202	0.01717	0.11331	0.49655	-0.59201
12	5669	0.05828	0.02200	0.01808	0.11422	0.51002	-0.60538
13	5669	0.05895	0.02199	0.01898	0.11494	0.51777	-0.61319
14	5669	0.05957	0.02195	0.01984	0.11533	0.51723	-0.62429
15	5669	0.06012	0.02188	0.02066	0.11531	0.50674	-0.64785
16	5669	0.06058	0.02176	0.02141	0.11484	0.48565	-0.69132
17	5669	0.06094	0.02161	0.02207	0.11425	0.45531	-0.75643
18	5669	0.06119	0.02145	0.02264	0.11282	0.41981	-0.83593
19	5669	0.06135	0.02130	0.02310	0.11152	0.38558	-0.91546
20	5669	0.06142	0.02119	0.02345	0.11060	0.35914	-0.98073
21	5669	0.06143	0.02114	0.02369	0.10994	0.34471	-1.02412
22	5669	0.06139	0.02117	0.02382	0.10935	0.34396	-1.04475
23	5669	0.06132	0.02130	0.02384	0.10883	0.35889	-1.04018
24	5669	0.06127	0.02160	0.02378	0.11231	0.40074	-0.98073
25	5669	0.06132	0.02229	0.02365	0.13494	0.53287	-0.63013
26	5428	0.05895	0.02040	0.02347	0.10475	0.45378	-0.88225
27	5428	0.05855	0.02035	0.02325	0.10683	0.47768	-0.83783
28	5428	0.05809	0.02026	0.02302	0.10963	0.50836	-0.76769
29	5428	0.05757	0.02015	0.02280	0.11353	0.55292	-0.64788
30	5428	0.05702	0.02007	0.02261	0.11870	0.62232	-0.43955

Table 26: Summary statistics for the annual changes in Canadian yield curve.

This table presents a summary statistics for annual changes in yields of Canadian zero-coupon bonds with maturity ranging from 3 month to 30 years during 1990-2012. The data is first differenced annual series. These results help us to estimate the possible changes in the term structure of interest rates in our simulation model.

Time to maturity	Obs	Mean	Std.Dev.	Min	Max	Skewness	Kurtosis
0.25	22	-0.00520	0.01433	-0.03814	0.01503	-0.51439	-0.39774
0.5	22	-0.00503	0.01351	-0.03533	0.01303	-0.55628	-0.61126
0.75	22	-0.00491	0.01276	-0.03274	0.01154	-0.55743	-0.74700
1	22	-0.00482	0.01205	-0.03053	0.01099	-0.54105	-0.79941
2	22	-0.00455	0.00972	-0.02427	0.01259	-0.33917	-0.66736
3	22	-0.00439	0.00832	-0.02041	0.01312	0.01193	-0.31141
4	22	-0.00430	0.00750	-0.01804	0.01322	0.31807	0.10417
5	22	-0.00422	0.00692	-0.01647	0.01281	0.50688	0.40520
6	22	-0.00413	0.00644	-0.01513	0.01212	0.62097	0.53652
7	22	-0.00405	0.00605	-0.01369	0.01146	0.70524	0.55974
8	22	-0.00396	0.00576	-0.01212	0.01099	0.76559	0.58118
9	22	-0.00389	0.00558	-0.01123	0.01074	0.78004	0.65120
10	22	-0.00384	0.00548	-0.01140	0.01057	0.73589	0.72552
11	22	-0.00381	0.00542	-0.01140	0.01036	0.64662	0.72913
12	22	-0.00380	0.00536	-0.01155	0.00996	0.53604	0.61892
13	22	-0.00379	0.00526	-0.01196	0.00931	0.41811	0.39479
14	22	-0.00379	0.00512	-0.01242	0.00839	0.29146	0.09674
15	22	-0.00377	0.00492	-0.01278	0.00721	0.14576	-0.19915
16	22	-0.00373	0.00469	-0.01304	0.00582	-0.02865	-0.39821
17	22	-0.00366	0.00444	-0.01318	0.00430	-0.23515	-0.41508
18	22	-0.00357	0.00421	-0.01323	0.00273	-0.46860	-0.21068
19	22	-0.00347	0.00402	-0.01319	0.00235	-0.70635	0.14346
20	22	-0.00337	0.00391	-0.01308	0.00213	-0.90123	0.45535
21	22	-0.00329	0.00386	-0.01294	0.00185	-1.01251	0.59419
22	22	-0.00324	0.00384	-0.01277	0.00149	-1.05089	0.62257
23	22	-0.00326	0.00382	-0.01260	0.00198	-1.04972	0.64511
24	22	-0.00339	0.00381	-0.01246	0.00244	-0.94519	0.52818
25	22	-0.00370	0.00413	-0.01237	0.00280	-0.71028	-0.37673
26	22	-0.00350	0.00404	-0.01235	0.00303	-0.67904	-0.10441
27	22	-0.00360	0.00433	-0.01242	0.00351	-0.43639	-0.44605
28	22	-0.00374	0.00479	-0.01257	0.00590	-0.16911	-0.48939
29	22	-0.00392	0.00546	-0.01283	0.00851	0.01551	-0.15643
30	22	-0.00414	0.00637	-0.01613	0.01122	0.00297	0.48350

Table 27: Summary statistics for Treasury bonds yields and mortgage rates (1990-2012).

This table presents summary statistics for the yield of Canadian zero-coupon bond and Canadian mortgage rate with maturity of one year, three years, and five years. We find that rates on mortgages are directly related to Treasury bond yields through a fixed premium. Therefore, table also presents a difference in mortgage rate and bond yield and we call it premium for the fixed rate mortgage rate. The analysis covers 1990-2012 years.

Summary Satatistics for Jan 1990-December 2012 time period									
	1-year mortgage rate	1-year Treasury bond yield	Premium for 1-year fixed rate mortgage	3-year mortgage rate	3-year Treasury bond yield	Premium for 3-year fixed rate mortgage	5-year mortgage rate	5-year Treasury bond yield	Premium for 5-year fixed rate mortgage
Number of observations	276	276	276	276	276	276	276	276	276
Mean	6.4008	4.3636	2.0373	7.0871	4.8725	2.2146	7.6091	5.2041	2.4051
Variance	5.3832	6.9287	0.5108	4.9011	5.9114	0.4130	3.8846	5.4570	0.5377
Standard Deviation	2.3202	2.6322	0.7147	2.2138	2.4313	0.6427	1.9709	2.3360	0.7333
Minimum	3.0000	0.4767	0.6280	3.7000	1.0100	0.9868	5.1900	1.2526	0.9675
Maximum	14.2500	12.8978	4.6247	14.2500	12.2060	4.8071	14.2500	11.7782	4.5632
Skewness	1.1495	0.8832	1.2860	1.0109	0.6262	1.1455	1.2928	0.5279	0.6436
Kurtosis	1.8757	0.8854	2.2579	1.2878	0.0737	2.3886	1.5785	-0.1823	-0.0902

Table 28: Summary statistics for Treasury bonds yields and mortgage rates (1990-1999).

This table presents a summary statistics for the yield of Canadian zero-coupon bond and Canadian mortgage rate with maturity of one year, three years, and five years. We find that rates on mortgages are directly related to Treasury bond yields through a fixed premium. Therefore, table also presents a difference in mortgage rate and bond yield and we call it premium for the fixed rate mortgage rate. In order to see how this premium was changing over years we divide our sample into two sub periods. This table presents data for 1990-1999 years.

Summary Satatistics for Jan 1990-December 1999 time period									
	1-year mortgage rate	1-year Treasury bond yield	Premium for 1-year fixed rate mortgage	3-year mortgage rate	3-year Treasury bond yield	Premium for 3-year fixed rate mortgage	5-year mortgage rate	5-year Treasury bond yield	Premium for 5-year fixed rate mortgage
Number of observations	120	120	120	120	120	120	120	120	120
Mean	7.9494	6.4645	1.4850	8.7165	6.9506	1.7659	9.0947	7.2380	1.8567
Variance	5.3400	5.2172	0.0900	4.4389	3.5838	0.1792	3.9685	3.1102	0.1925
Std. Dev.	2.3108	2.2841	0.3000	2.1069	1.8931	0.4233	1.9921	1.7636	0.4387
Min	5.0500	3.2611	0.6280	6.2000	4.5664	0.9868	6.6000	4.6773	0.9675
Max	14.2500	12.8978	2.3064	14.2500	12.2060	3.2998	14.2500	11.7782	3.4564
Skewness	1.2833	1.1233	-0.1357	1.0421	0.8287	1.1807	0.8906	0.5832	0.8196
Kurtosis	0.9677	0.6188	0.7295	0.3747	-0.1625	1.9446	0.1225	-0.5214	1.3306

Table 29: Summary statistics for Treasury bonds yields and mortgage rates (2000-2012).

This table presents a summary statistics for the yield of Canadian zero-coupon bond and Canadian mortgage rate with maturity of one year, three years, and five years. We find that rates on mortgages are directly related to Treasury bond yields through a fixed premium. Therefore, table also presents a difference in mortgage rate and bond yield and we call it premium for the fixed rate mortgage rate. In order to see how this premium was changing over years we divide our sample into two sub periods. This table presents data for 2000-2012 years.

Summary Satatistics for Jan 2000-December 2012 time period									
	1-year mortgage rate	1-year Treasury bond yield	Premium for 1-year fixed rate mortgage	3-year mortgage rate	3-year Treasury bond yield	Premium for 3-year fixed rate mortgage	5-year mortgage rate	5-year Treasury bond yield	Premium for 5-year fixed rate mortgage
Number of observations	156	156	156	156	156	156	156	156	156
Mean	5.2096	2.7475	2.4621	5.8337	3.2739	2.5597	6.4664	3.6395	2.8269
Variance	2.1663	2.2419	0.4193	1.6509	1.8215	0.3195	0.8225	1.6277	0.3943
Std. Dev.	1.4718	1.4973	0.6476	1.2849	1.3496	0.5652	0.9069	1.2758	0.6279
Min	3.0000	0.4767	1.7322	3.7000	1.0100	1.7111	5.1900	1.2526	2.0276
Max	8.3000	6.0986	4.6247	8.5500	6.3248	4.8071	8.7500	6.4068	4.5632
Skewness	0.2712	0.2895	1.7270	0.0687	0.1460	1.9682	0.4401	-0.0740	0.7814
Kurtosis	-1.1023	-0.7363	2.2350	-0.9639	-0.5897	3.9126	-0.5454	-0.6002	-0.6479

Table 30: Type I Bank income

Type I Bank generates only net interest income by taking money from depositors and giving loans to creditors. Firstly, we simulate net interest income of our hypothetical bank under stable economy condition with no change in the interest rates. However, different structures of the balance sheets yield different results of the net interest income and therefore, we present 121 various balance sheet structures. In these balance sheet structures fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. This table presents average dollar value of the net interest income across five years for each composition of the balance sheet.

Fixed Assets/Liabilities	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0%	$1,493,055,037	$1,523,580,338	$1,553,506,878	$1,583,743,092	$1,613,965,629	$1,647,983,670	$1,677,540,991	$1,702,710,043	$1,732,351,650	$1,762,675,491	$1,785,588,660
10%	$1,599,205,622	$1,629,932,259	$1,661,393,417	$1,690,793,252	$1,720,892,243	$1,752,450,103	$1,783,877,510	$1,809,330,962	$1,844,852,194	$1,876,155,861	$1,901,091,651
20%	$1,707,155,060	$1,736,522,892	$1,765,789,989	$1,798,126,941	$1,828,466,404	$1,860,439,626	$1,890,842,508	$1,920,698,449	$1,950,018,839	$1,982,879,575	$2,009,908,164
30%	$1,818,056,620	$1,846,085,501	$1,876,413,534	$1,904,293,172	$1,937,650,481	$1,965,782,805	$1,996,188,661	$2,026,407,694	$2,056,877,958	$2,086,070,133	$2,119,231,137
40%	$1,919,214,098	$1,951,002,115	$1,980,775,982	$2,014,276,892	$2,044,485,408	$2,073,322,703	$2,103,359,771	$2,134,077,614	$2,166,798,113	$2,193,575,981	$2,227,335,205
50%	$2,031,720,673	$2,057,626,327	$2,090,238,628	$2,120,582,295	$2,150,157,365	$2,180,975,074	$2,211,731,705	$2,242,814,221	$2,269,817,333	$2,303,460,649	$2,334,515,597
60%	$2,137,156,095	$2,166,741,538	$2,199,319,084	$2,229,867,505	$2,258,997,096	$2,289,114,263	$2,318,634,462	$2,348,111,021	$2,379,685,899	$2,410,601,853	$2,445,503,684
70%	$2,240,468,308	$2,267,421,579	$2,308,309,361	$2,335,050,656	$2,364,723,642	$2,397,043,783	$2,425,999,550	$2,456,872,800	$2,487,003,634	$2,515,772,761	$2,547,823,028
80%	$2,344,764,682	$2,377,915,913	$2,410,411,107	$2,448,375,432	$2,474,140,428	$2,502,924,359	$2,532,853,286	$2,563,358,745	$2,594,358,602	$2,623,692,513	$2,652,697,798
90%	$2,452,326,042	$2,491,045,366	$2,524,870,875	$2,545,366,099	$2,580,359,277	$2,610,348,830	$2,641,429,165	$2,670,804,556	$2,701,331,981	$2,732,271,286	$2,764,650,437
100%	$2,562,201,639	$2,599,473,313	$2,630,249,979	$2,658,131,502	$2,690,527,804	$2,716,899,896	$2,749,153,433	$2,749,667,256	$2,808,559,610	$2,839,116,284	$2,868,800,304

Table 31: Percentage change in Type I Bank income from having fixed rate assets and liabilities

Type I Bank is generating net interest income. Firstly, we simulate net interest income of our hypothetical bank under stable economy condition with no change in the interest rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. This table presents percentage changes in income as we add more fixed rate assets or liabilities. Therefore, the base value according to which we compare the change in income refers to the net interest income of a bank with 0% fixed rate assets and 0% rate liabilities.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	0%	2%	4%	6%	8%	10%	12%	14%	16%	18%	20%
10%	7%	9%	11%	13%	15%	17%	19%	21%	24%	26%	27%
20%	14%	16%	18%	20%	22%	25%	27%	29%	31%	33%	35%
30%	22%	24%	26%	28%	30%	32%	34%	36%	38%	40%	42%
40%	29%	31%	33%	35%	37%	39%	41%	43%	45%	47%	49%
50%	36%	38%	40%	42%	44%	46%	48%	50%	52%	54%	56%
60%	43%	45%	47%	49%	51%	53%	55%	57%	59%	61%	64%
70%	50%	52%	55%	56%	58%	61%	62%	65%	67%	68%	71%
80%	57%	59%	61%	64%	66%	68%	70%	72%	74%	76%	78%
90%	64%	67%	69%	70%	73%	75%	77%	79%	81%	83%	85%
100%	72%	74%	76%	78%	80%	82%	84%	84%	88%	90%	92%

Table 32: Average standard deviation of Type I Bank income

Type I Bank only generates net interest income. This table shows dollar values of standard deviations of bank income across five years. We simulate income for five years and calculate standard deviation of those incomes. As we run simulation 100 times, we calculate the average standard deviation and report it in this table. Standard deviation is different for every balance sheet structure. We present 121 various balance sheet structures, where fixed assets can vary from 0% to 100% and fixed rate liabilities can also vary from 0% to 100%.

Fixed Assets/Liabilities	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0%	$103,481,070	$113,882,647	$123,356,499	$133,589,096	$143,807,383	$156,964,283	$166,678,887	$172,768,614	$182,139,536	$193,420,818	$200,531,239
10%	$105,881,397	$117,458,339	$128,007,574	$137,144,072	$147,284,934	$156,297,218	$169,555,962	$175,639,649	$190,237,578	$201,043,844	$209,833,297
20%	$112,339,362	$121,276,799	$129,982,835	$141,378,314	$152,285,044	$162,754,651	$172,899,643	$182,305,674	$191,852,360	$204,683,366	$211,270,120
30%	$118,242,088	$126,000,519	$135,889,265	$144,312,528	$154,943,242	$164,886,244	$174,962,728	$185,586,101	$196,553,620	$206,151,556	$217,609,666
40%	$118,098,359	$129,473,678	$137,753,374	$149,139,135	$160,175,826	$169,366,415	$179,570,270	$188,916,829	$202,612,070	$209,258,093	$222,613,357
50%	$126,809,174	$133,863,518	$143,819,761	$153,921,407	$161,356,208	$173,566,607	$184,026,944	$194,131,946	$202,182,357	$215,845,060	$226,647,309
60%	$128,786,609	$138,465,004	$150,218,778	$159,725,865	$168,010,387	$178,508,418	$187,277,863	$197,294,731	$207,312,115	$219,115,639	$233,051,811
70%	$129,265,994	$136,682,444	$154,382,722	$160,943,074	$171,204,191	$182,511,844	$192,216,974	$201,783,219	$212,351,887	$221,475,344	$233,347,790
80%	$132,657,892	$142,464,249	$155,271,698	$170,495,746	$176,632,754	$185,346,847	$195,760,418	$205,764,329	$215,331,464	$224,893,423	$234,726,921
90%	$136,927,091	$154,359,427	$165,998,532	$167,530,665	$180,112,447	$189,225,685	$199,027,026	$209,234,709	$219,720,030	$230,533,235	$242,102,828
100%	$144,820,656	$157,484,620	$165,406,652	$174,049,487	$187,424,016	$192,510,002	$204,171,005	$205,845,168	$223,250,540	$234,383,346	$243,205,887

Table 33 : Change in Type I Bank income assuming 25 basis points expected rise in rates every year

Type I Bank only generates net interest income. We simulate income of our hypothetical bank under scenario of 25 basis points rise in rates every year during the five year time period. This table presents percentage changes in income from change in rates. Our benchmark is income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	1%	2%	3%	4%	5%	5%	7%	8%	9%	10%	11%
10%	-1%	1%	2%	3%	4%	4%	5%	7%	7%	8%	9%
20%	-2%	0%	1%	1%	2%	3%	4%	5%	6%	7%	8%
30%	-3%	-1%	-1%	1%	1%	2%	3%	4%	5%	6%	6%
40%	-3%	-2%	-1%	0%	0%	1%	2%	3%	4%	5%	5%
50%	-4%	-3%	-2%	-1%	0%	0%	1%	2%	3%	3%	4%
60%	-5%	-3%	-3%	-2%	-1%	0%	0%	1%	2%	3%	3%
70%	-5%	-4%	-4%	-3%	-2%	-1%	0%	0%	1%	2%	2%
80%	-5%	-5%	-4%	-4%	-3%	-2%	-1%	0%	0%	1%	2%
90%	-6%	-6%	-5%	-4%	-3%	-2%	-2%	-1%	0%	0%	1%
100%	-7%	-6%	-5%	-4%	-4%	-3%	-2%	-2%	-1%	0%	0%

Table 34: Change in standard deviation of Type I Bank income assuming 25 basis points expected rise in rates every year

Type I Bank only generates net interest income. We simulate income of our hypothetical bank under scenario of 25 basis points rise in rates every year during the five year time period. This table presents percentage changes in standard deviation of income from change in rates. Our benchmark is standard deviation of income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	20%	24%	29%	33%	36%	33%	37%	45%	45%	47%	51%
10%	15%	20%	21%	26%	30%	33%	33%	41%	39%	39%	42%
20%	6%	11%	18%	21%	23%	26%	30%	32%	34%	34%	40%
30%	-4%	8%	10%	16%	18%	22%	26%	28%	29%	32%	33%
40%	-7%	1%	6%	10%	13%	17%	20%	23%	25%	29%	27%
50%	-12%	-6%	-1%	5%	10%	12%	16%	18%	22%	22%	26%
60%	-20%	-6%	-6%	1%	3%	7%	11%	15%	17%	19%	20%
70%	-21%	-8%	-10%	-3%	-1%	4%	7%	10%	13%	17%	19%
80%	-19%	-15%	-14%	-12%	-5%	-1%	3%	6%	10%	13%	16%
90%	-21%	-25%	-19%	-13%	-9%	-3%	1%	3%	6%	9%	10%
100%	-29%	-26%	-15%	-16%	-13%	-8%	-4%	-5%	3%	6%	9%

Table 35 : Change in Type I Bank income assuming 75 basis points expected rise in rates every year

Type I bank only generates net interest income. We simulate income of our hypothetical bank under scenario of 75 basis points rise in rates every year during the five year time period. This table presents percentage changes in income from change in rates. Our benchmark is income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	2%	5%	9%	12%	15%	18%	21%	24%	27%	29%	32%
10%	-2%	2%	5%	8%	11%	14%	16%	19%	22%	24%	27%
20%	-5%	-2%	2%	4%	7%	10%	13%	15%	18%	20%	22%
30%	-8%	-4%	-2%	1%	4%	7%	9%	12%	14%	17%	19%
40%	-9%	-7%	-4%	-1%	1%	4%	6%	9%	11%	13%	15%
50%	-12%	-9%	-7%	-4%	-1%	1%	4%	6%	8%	10%	12%
60%	-14%	-11%	-9%	-6%	-4%	-1%	1%	3%	6%	8%	9%
70%	-15%	-13%	-11%	-8%	-6%	-4%	-1%	1%	3%	5%	7%
80%	-17%	-15%	-12%	-10%	-8%	-5%	-3%	-1%	1%	3%	5%
90%	-18%	-16%	-14%	-11%	-9%	-7%	-5%	-3%	-1%	1%	3%
100%	-19%	-18%	-15%	-13%	-11%	-9%	-7%	-7%	-3%	-1%	1%

Table 36: Change in standard deviation of Type I Bank income assuming 75 basis points expected rise in rates every year

Type I bank only generates net interest income. We simulate income of our hypothetical bank under scenario of 75 basis points rise in rates every year during the five year time period. This table presents percentage changes in standard deviation of income from change in rates. Our benchmark is standard deviation of income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	64%	75%	88%	96%	107%	110%	117%	127%	138%	139%	146%
10%	44%	55%	66%	78%	88%	98%	101%	114%	114%	121%	125%
20%	24%	36%	51%	61%	71%	79%	87%	94%	102%	111%	115%
30%	6%	20%	31%	45%	56%	66%	76%	82%	88%	96%	99%
40%	2%	4%	17%	31%	40%	50%	60%	70%	75%	83%	89%
50%	-18%	-7%	3%	15%	28%	37%	46%	54%	65%	69%	74%
60%	-24%	-15%	-12%	0%	13%	23%	34%	43%	53%	60%	63%
70%	-22%	-24%	-19%	-8%	2%	10%	23%	32%	40%	48%	56%
80%	-20%	-29%	-26%	-22%	-10%	2%	11%	20%	31%	39%	46%
90%	-14%	-31%	-30%	-26%	-21%	-9%	0%	11%	19%	27%	34%
100%	-18%	-29%	-39%	-30%	-27%	-19%	-10%	-11%	8%	18%	26%

Table 37: Change in Type I Bank income assuming 75 basis points expected drop in rates every year

Type I bank only generates net interest income. We simulate income of our hypothetical bank under scenario of 75 basis points drop in rates every year during the five year time period. This table presents percentage changes in income from change in rates. Our benchmark is income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	-2%	-5%	-9%	-12%	-15%	-18%	-21%	-24%	-26%	-29%	-31%
10%	2%	-2%	-5%	-8%	-11%	-14%	-17%	-19%	-22%	-25%	-27%
20%	5%	2%	-1%	-4%	-7%	-10%	-13%	-15%	-18%	-20%	-23%
30%	7%	4%	1%	-1%	-4%	-7%	-9%	-12%	-14%	-17%	-19%
40%	10%	7%	4%	1%	-1%	-4%	-6%	-9%	-11%	-14%	-16%
50%	12%	9%	6%	4%	1%	-1%	-4%	-6%	-8%	-11%	-13%
60%	14%	11%	8%	6%	4%	1%	-1%	-3%	-6%	-8%	-10%
70%	16%	13%	10%	8%	6%	3%	1%	-1%	-3%	-5%	-7%
80%	18%	15%	12%	9%	8%	5%	3%	1%	-1%	-3%	-5%
90%	19%	16%	13%	12%	9%	7%	5%	3%	1%	-1%	-3%
100%	20%	17%	15%	13%	10%	9%	7%	7%	3%	1%	-1%

Table 38: Change in standard deviation of Type I Bank income assuming 75 basis points expected drop in rates every year

Type I bank only generates net interest income. We simulate income of our hypothetical bank under scenario of 75 basis points drop in rates every year during the five year time period. This table presents percentage changes in standard deviation of income from change in rates. Our benchmark is standard deviation of income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	-57%	-70%	-81%	-85%	-84%	-80%	-74%	-67%	-60%	-59%	-50%
10%	-34%	-51%	-64%	-76%	-82%	-86%	-84%	-82%	-77%	-70%	-69%
20%	-17%	-30%	-46%	-60%	-71%	-79%	-84%	-86%	-84%	-82%	-76%
30%	2%	-12%	-30%	-43%	-55%	-65%	-73%	-79%	-83%	-85%	-84%
40%	26%	5%	-12%	-26%	-39%	-50%	-59%	-68%	-75%	-81%	-83%
50%	38%	23%	4%	-11%	-24%	-36%	-47%	-57%	-62%	-71%	-78%
60%	56%	34%	18%	2%	-10%	-22%	-34%	-43%	-52%	-60%	-67%
70%	77%	57%	32%	16%	6%	-9%	-22%	-32%	-42%	-49%	-57%
80%	94%	70%	46%	23%	15%	3%	-9%	-19%	-30%	-39%	-46%
90%	109%	76%	55%	47%	29%	14%	3%	-8%	-19%	-28%	-38%
100%	113%	87%	73%	55%	33%	25%	13%	11%	-8%	-18%	-26%

Table 39: Change in Type I Bank hedged income assuming 75 basis points expected rise in rates every year

Type I bank only generates net interest income. We simulate hedged income of our hypothetical bank under scenario of 75 basis points rise in rates every year during the five year time period. This table presents percentage changes in income from change in rates. Our benchmark is income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%	0%	0%
10%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%	1%
20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
30%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
40%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
50%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
60%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
70%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
80%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%
90%	0%	0%	-1%	0%	0%	0%	0%	0%	0%	0%	0%
100%	-1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table 40: Change in standard deviation of Type I Bank hedged income assuming 75 basis points expected rise in rates every year

Type I bank only generates net interest income. We simulate hedged income of our hypothetical bank under scenario of 75 basis points rise in rates every year during the five year time period. This table presents percentage changes in standard deviation of income from change in rates. Our benchmark is standard deviation of income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	1%	0%	-2%	4%	-1%	1%	4%	5%	2%	3%	3%
10%	-2%	1%	-1%	1%	0%	5%	4%	2%	4%	1%	8%
20%	0%	3%	0%	2%	0%	0%	5%	5%	5%	1%	2%
30%	0%	2%	2%	2%	0%	1%	-2%	2%	1%	0%	3%
40%	-4%	2%	1%	-2%	0%	0%	2%	-1%	2%	2%	2%
50%	3%	-2%	2%	1%	0%	1%	-1%	2%	1%	1%	1%
60%	0%	-2%	2%	0%	0%	1%	0%	1%	-1%	-1%	2%
70%	5%	-1%	-2%	0%	0%	1%	0%	-1%	0%	1%	-1%
80%	0%	8%	3%	2%	0%	-1%	0%	0%	-1%	-1%	-1%
90%	2%	-4%	-3%	2%	3%	3%	2%	-1%	1%	1%	0%
100%	4%	5%	7%	-3%	1%	3%	1%	1%	1%	1%	0%

Table 41: Change in Type I Bank hedged income assuming 75 basis points expected drop in rates every

Type I bank only generates net interest income. We simulate hedged income of our hypothetical bank under scenario of 75 basis points drop in rates every year during the five year time period. This table presents percentage changes in income from change in rates. Our benchmark is income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%
10%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
30%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
40%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%
50%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%	-1%
60%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%
70%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%
80%	1%	0%	0%	-1%	0%	0%	0%	0%	0%	0%	0%
90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
100%	0%	0%	0%	0%	-1%	0%	0%	0%	0%	0%	0%

Table 42: Change in standard deviation of Type I Bank hedged income assuming 75 basis points expected drop in rates every year

Type I bank only generates net interest income. We simulate hedged income of our hypothetical bank under scenario of 75 basis points drop in rates every year during the five year time period. This table presents percentage changes in standard deviation of income from change in rates. Our benchmark is standard deviation of income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	3%	-1%	0%	-4%	1%	-1%	-1%	4%	10%	9%	11%
10%	0%	-2%	-3%	-2%	-1%	2%	-3%	5%	2%	3%	3%
20%	-2%	-2%	-1%	-1%	-1%	-1%	-5%	-2%	0%	6%	4%
30%	-1%	-3%	-3%	-2%	-2%	1%	1%	-3%	0%	2%	-1%
40%	12%	-2%	-1%	-1%	-2%	-2%	-2%	1%	0%	-1%	-2%
50%	0%	0%	0%	-1%	1%	-2%	-2%	-3%	-1%	-6%	-6%
60%	0%	2%	-4%	-5%	-2%	-4%	-2%	-2%	1%	-2%	-6%
70%	10%	8%	-1%	1%	-1%	-5%	-3%	-2%	-3%	-1%	-3%
80%	11%	2%	3%	-6%	-4%	0%	-1%	-2%	1%	1%	-1%
90%	5%	0%	-2%	2%	-3%	-1%	0%	-1%	-2%	-3%	-3%
100%	3%	-3%	-3%	4%	-6%	-3%	-3%	-6%	-3%	-2%	-2%

Table 43: Type II Bank income

Type II bank, in addition to net interest income, presents some fee-based income that is related to generation of loans and deposits. This fee-based income is called traditional and is generated through deposit and payment services, lending fees, and card fees. In this table we present an average dollar value of five-year income simulated under stable economy condition with no change in the interest rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0%	$2,196,742,822	$2,229,403,053	$2,259,282,575	$2,290,525,414	$2,319,616,626	$2,349,402,238	$2,381,633,227	$2,408,874,786	$2,438,109,202	$2,475,483,081	$2,498,270,032
10%	$2,306,474,299	$2,338,480,973	$2,365,239,627	$2,397,271,509	$2,426,442,630	$2,455,892,703	$2,489,978,206	$2,519,107,431	$2,550,812,746	$2,579,889,660	$2,602,730,106
20%	$2,412,565,128	$2,442,433,974	$2,472,980,721	$2,505,474,053	$2,535,421,912	$2,564,873,170	$2,595,187,596	$2,629,106,540	$2,661,385,718	$2,689,196,432	$2,713,039,007
30%	$2,523,436,678	$2,551,168,108	$2,580,541,006	$2,610,794,543	$2,641,108,965	$2,671,676,703	$2,704,189,236	$2,733,144,955	$2,766,192,720	$2,793,958,919	$2,825,940,617
40%	$2,626,179,978	$2,655,576,681	$2,687,817,904	$2,719,458,452	$2,751,129,772	$2,779,422,881	$2,809,754,519	$2,840,131,442	$2,872,450,604	$2,900,782,619	$2,925,912,677
50%	$2,733,501,601	$2,767,680,202	$2,795,479,721	$2,827,721,768	$2,855,467,486	$2,886,781,919	$2,918,086,742	$2,948,780,401	$2,979,138,016	$3,009,441,263	$3,037,948,706
60%	$2,846,201,950	$2,866,707,242	$2,902,502,680	$2,932,750,846	$2,964,336,363	$2,994,758,657	$3,024,177,558	$3,054,487,918	$3,086,717,410	$3,114,617,732	$3,148,266,895
70%	$2,947,325,802	$2,981,626,582	$3,010,973,695	$3,040,995,089	$3,075,301,035	$3,100,951,863	$3,131,842,605	$3,162,398,098	$3,192,986,480	$3,223,080,227	$3,254,909,212
80%	$3,060,054,923	$3,087,582,792	$3,118,867,689	$3,144,640,887	$3,181,496,060	$3,208,601,418	$3,239,407,144	$3,269,342,033	$3,299,321,325	$3,331,749,110	$3,359,978,826
90%	$3,163,426,034	$3,193,797,095	$3,222,581,488	$3,262,281,930	$3,283,695,374	$3,315,808,232	$3,345,904,964	$3,378,441,111	$3,407,742,740	$3,438,740,489	$3,468,588,564
100%	$3,280,417,756	$3,311,079,658	$3,337,353,818	$3,359,446,210	$3,396,093,838	$3,424,078,656	$3,452,018,257	$3,452,387,693	$3,514,581,628	$3,545,103,965	$3,575,941,221

Table 44: Average standard deviation of Type II Bank income

Type II bank, in addition to net interest income, presents some fee-based income that is related to generation of loans and deposits. This fee-based income is called traditional and is generated through deposit and payment services, lending fees, and card fees. This table shows dollar values of standard deviations of bank income across five years. We simulate income for five years and calculate standard deviation of those incomes. As we run simulation 100 times, we calculate the average standard deviation and report it in this table. Standard deviation is different for every balance sheet structure. We present 121 various balance sheet structures, where fixed assets can vary from 0% to 100% and fixed rate liabilities can also vary from 0% to 100%.

Fixed Assets/Liabilities	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0%	$104,871,934	$116,275,671	$125,756,027	$136,528,244	$145,951,138	$156,526,172	$167,220,262	$175,617,381	$184,480,115	$200,981,697	$206,021,177
10%	$111,257,449	$119,983,240	$128,913,482	$140,039,969	$149,554,632	$159,662,029	$172,007,162	$180,471,089	$191,990,075	$201,339,573	$207,302,625
20%	$114,505,432	$122,844,237	$134,198,242	$144,020,649	$154,073,746	$164,236,953	$173,810,797	$186,296,924	$198,640,917	$208,376,541	$213,379,501
30%	$121,392,236	$128,350,621	$136,744,019	$147,594,285	$157,262,753	$168,159,707	$178,536,527	$188,052,564	$200,982,015	$209,342,596	$220,367,093
40%	$122,750,006	$130,716,604	$143,466,657	$151,607,227	$162,991,352	$171,499,387	$182,250,170	$192,227,388	$203,906,837	$211,453,730	$219,553,388
50%	$125,124,314	$137,141,570	$146,774,523	$156,780,452	$164,729,753	$175,344,717	$186,767,699	$197,369,650	$206,344,332	$217,172,437	$227,285,346
60%	$133,771,222	$135,390,130	$150,946,758	$157,740,517	$169,802,878	$179,813,857	$190,134,590	$199,594,398	$211,052,617	$219,514,766	$233,085,366
70%	$134,308,386	$146,933,870	$156,661,993	$163,874,126	$177,600,185	$183,326,269	$194,157,998	$203,761,055	$214,705,922	$224,998,860	$235,426,853
80%	$141,933,870	$149,585,345	$162,628,442	$166,244,459	$180,526,640	$187,189,811	$199,313,060	$208,038,477	$218,450,134	$229,643,289	$238,394,091
90%	$144,674,208	$152,205,565	$157,627,003	$177,253,717	$180,283,979	$191,425,414	$202,082,759	$213,651,355	$222,482,892	$233,275,042	$242,733,180
100%	$157,675,538	$166,881,998	$171,074,870	$173,667,002	$187,452,235	$196,094,942	$203,928,371	$204,927,422	$226,248,593	$236,078,396	$246,577,852

Table 45: Change in Type II Bank income assuming 25 basis points expected rise in rates every year

Type II bank, in addition to net interest income, presents some fee-based income that is related to generation of loans and deposits. This fee-based income is called traditional and is generated through deposit and payment services, lending fees, and card fees. We simulate income of our hypothetical bank under scenario of 25 basis points rise in rates every year during the five year time period. This table presents percentage changes in income from change in rates. Our benchmark is income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	0%	1%	2%	3%	3%	4%	5%	6%	6%	7%	8%
10%	0%	0%	1%	2%	3%	3%	4%	5%	5%	6%	7%
20%	-1%	0%	0%	1%	2%	2%	3%	4%	4%	5%	6%
30%	-2%	-1%	0%	0%	1%	2%	2%	3%	3%	4%	5%
40%	-2%	-2%	-1%	0%	0%	1%	2%	2%	3%	3%	4%
50%	-3%	-2%	-2%	-1%	0%	0%	1%	1%	2%	3%	3%
60%	-4%	-3%	-2%	-1%	-1%	0%	0%	1%	1%	2%	2%
70%	-4%	-3%	-3%	-2%	-2%	-1%	0%	0%	1%	1%	2%
80%	-4%	-4%	-3%	-3%	-2%	-1%	-1%	0%	0%	1%	1%
90%	-5%	-4%	-4%	-3%	-2%	-2%	-1%	-1%	0%	0%	1%
100%	-5%	-5%	-4%	-3%	-3%	-2%	-2%	-2%	-1%	0%	0%

Table 46: Change in standard deviation of Type II Bank income assuming 25 basis points expected rise in rates every year

Type II bank, in addition to net interest income, presents some fee-based income that is related to generation of loans and deposits. This fee-based income is called traditional and is generated through deposit and payment services, lending fees, and card fees. We simulate income of our hypothetical bank under scenario of 25 basis points rise in rates every year during the five year time period. This table presents percentage changes in standard deviation of income from change in rates. Our benchmark is standard deviation of income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	22%	25%	30%	30%	34%	37%	39%	42%	44%	45%	48%
10%	13%	16%	22%	26%	29%	32%	33%	36%	40%	39%	46%
20%	5%	10%	17%	20%	24%	25%	30%	30%	31%	33%	39%
30%	-1%	6%	11%	15%	18%	21%	24%	24%	29%	32%	32%
40%	-7%	3%	4%	9%	13%	17%	19%	23%	26%	29%	32%
50%	-9%	-5%	-2%	3%	9%	12%	15%	18%	20%	22%	26%
60%	-18%	-6%	-7%	3%	4%	8%	11%	15%	17%	20%	20%
70%	-11%	-9%	-10%	-3%	-1%	3%	7%	11%	12%	15%	18%
80%	-23%	-18%	-12%	-10%	-6%	1%	2%	7%	10%	11%	15%
90%	-27%	-21%	-15%	-15%	-8%	-2%	0%	2%	6%	9%	11%
100%	-29%	-26%	-22%	-16%	-13%	-8%	-3%	-4%	3%	6%	8%

Table 47: Change in Type II Bank income assuming 75 basis points expected rise in rates every year

Type II bank, in addition to net interest income, presents some fee-based income that is related to generation of loans and deposits. This fee-based income is called traditional and is generated through deposit and payment services, lending fees, and card fees. We simulate income of our hypothetical bank under scenario of 75 basis points rise in rates every year during the five year time period. This table presents percentage changes in income from change in rates. Our benchmark is income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	1%	4%	6%	8%	10%	12%	15%	17%	19%	20%	23%
10%	-1%	1%	3%	5%	8%	10%	12%	14%	15%	17%	20%
20%	-3%	-1%	1%	3%	5%	7%	9%	11%	13%	15%	17%
30%	-5%	-3%	-1%	1%	3%	5%	7%	9%	10%	12%	14%
40%	-7%	-5%	-3%	-1%	1%	3%	5%	6%	8%	10%	12%
50%	-9%	-7%	-5%	-3%	-1%	1%	3%	4%	6%	8%	10%
60%	-11%	-8%	-7%	-5%	-3%	-1%	1%	3%	4%	6%	7%
70%	-12%	-10%	-8%	-6%	-5%	-3%	-1%	1%	2%	4%	6%
80%	-13%	-11%	-9%	-8%	-6%	-4%	-3%	-1%	1%	2%	4%
90%	-14%	-13%	-11%	-9%	-7%	-6%	-4%	-2%	-1%	1%	2%
100%	-16%	-14%	-12%	-11%	-9%	-7%	-5%	-5%	-2%	-1%	1%

Table 48: Change in standard deviation of Type II Bank income assuming 75 basis points expected rise in rates every year

Type II bank, in addition to net interest income, presents some fee-based income that is related to generation of loans and deposits. This fee-based income is called traditional and is generated through deposit and payment services, lending fees, and card fees. We simulate income of our hypothetical bank under scenario of 75 basis points rise in rates every year during the five year time period. This table presents percentage changes in standard deviation of income from change in rates. Our benchmark is standard deviation of income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	62%	74%	86%	94%	105%	113%	121%	124%	133%	130%	144%
10%	40%	53%	67%	77%	87%	96%	100%	109%	114%	121%	130%
20%	21%	38%	47%	60%	70%	79%	88%	94%	98%	105%	114%
30%	8%	19%	33%	43%	54%	63%	73%	81%	84%	96%	99%
40%	-9%	6%	16%	28%	38%	50%	58%	66%	72%	84%	91%
50%	-14%	-9%	5%	15%	26%	37%	46%	54%	63%	71%	77%
60%	-25%	-19%	-10%	3%	13%	22%	34%	43%	51%	58%	64%
70%	-29%	-25%	-19%	-10%	0%	13%	22%	32%	40%	48%	54%
80%	-33%	-28%	-28%	-17%	-10%	2%	10%	20%	29%	37%	45%
90%	-24%	-29%	-30%	-27%	-18%	-9%	0%	9%	20%	26%	35%
100%	-25%	-34%	-35%	-33%	-28%	-20%	-10%	-9%	9%	18%	26%

Table 49: Change in Type II Bank income assuming 75 basis points expected drop in rates every year

Type II bank, in addition to net interest income, presents some fee-based income that is related to generation of loans and deposits. This fee-based income is called traditional and is generated through deposit and payment services, lending fees, and card fees. We simulate income of our hypothetical bank under scenario of 75 basis points drop in rates every year during the five year time period. This table presents percentage changes in income from change in rates. Our benchmark is income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	-1%	-4%	-6%	-8%	-10%	-13%	-15%	-17%	-19%	-21%	-23%
10%	1%	-1%	-3%	-6%	-8%	-10%	-12%	-14%	-16%	-18%	-19%
20%	3%	1%	-1%	-3%	-5%	-7%	-9%	-11%	-13%	-15%	-17%
30%	5%	3%	1%	-1%	-3%	-5%	-7%	-9%	-11%	-12%	-14%
40%	7%	5%	3%	1%	-1%	-3%	-5%	-7%	-8%	-10%	-12%
50%	9%	7%	5%	3%	1%	-1%	-3%	-5%	-6%	-8%	-10%
60%	10%	9%	6%	5%	3%	1%	-1%	-3%	-4%	-6%	-8%
70%	12%	10%	8%	6%	4%	3%	1%	-1%	-3%	-4%	-6%
80%	13%	11%	9%	8%	6%	4%	2%	1%	-1%	-3%	-4%
90%	14%	12%	11%	9%	7%	6%	4%	2%	1%	-1%	-2%
100%	15%	14%	12%	10%	8%	7%	5%	5%	2%	1%	-1%

Table 50: Change in standard deviation of Type II Bank income assuming 75 basis points expected drop in rates every year

Type II bank, in addition to net interest income, presents some fee-based income that is related to generation of loans and deposits. This fee-based income is called traditional and is generated through deposit and payment services, lending fees, and card fees. We simulate income of our hypothetical bank under scenario of 75 basis points drop in rates every year during the five year time period. This table presents percentage changes in standard deviation of income from change in rates. Our benchmark is standard deviation of income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	-57%	-70%	-80%	-85%	-86%	-79%	-76%	-68%	-64%	-61%	-53%
10%	-35%	-51%	-64%	-75%	-82%	-85%	-86%	-82%	-77%	-73%	-68%
20%	-15%	-32%	-46%	-59%	-69%	-78%	-83%	-85%	-85%	-84%	-80%
30%	4%	-14%	-30%	-41%	-54%	-64%	-72%	-79%	-82%	-85%	-85%
40%	19%	6%	-13%	-27%	-39%	-49%	-59%	-68%	-74%	-80%	-83%
50%	41%	21%	2%	-13%	-24%	-36%	-46%	-55%	-62%	-71%	-75%
60%	51%	38%	17%	4%	-11%	-23%	-33%	-42%	-53%	-58%	-66%
70%	74%	48%	29%	17%	0%	-10%	-21%	-30%	-40%	-48%	-57%
80%	88%	62%	45%	33%	15%	3%	-10%	-19%	-29%	-39%	-45%
90%	89%	80%	64%	39%	30%	15%	1%	-10%	-18%	-27%	-37%
100%	99%	78%	62%	57%	39%	24%	14%	14%	-9%	-18%	-26%

Table 51: Change in Type II Bank hedged income assuming 75 basis points expected rise in rates every year

Type II bank, in addition to net interest income, presents some fee-based income that is related to generation of loans and deposits. This fee-based income is called traditional and is generated through deposit and payment services, lending fees, and card fees. We simulate hedged income of our hypothetical bank under scenario of 75 basis points rise in rates every year during the five year time period. This table presents percentage changes in hedged income from change in rates. Our benchmark is income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%
10%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
30%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
40%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
50%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
60%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
70%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
80%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
100%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table 52: Change in standard deviation of Type II Bank hedged income assuming 75 basis points expected rise in rates every year

Type II bank, in addition to net interest income, presents some fee-based income that is related to generation of loans and deposits. This fee-based income is called traditional and is generated through deposit and payment services, lending fees, and card fees. We simulate hedged income of our hypothetical bank under scenario of 75 basis points rise in rates every year during the five year time period. This table presents percentage changes in standard deviation of hedged income from change in rates. Our benchmark is standard deviation of income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	2%	-2%	-1%	4%	0%	0%	2%	5%	6%	6%	3%
10%	-1%	2%	1%	2%	2%	2%	3%	2%	7%	4%	4%
20%	1%	-2%	1%	0%	2%	3%	1%	0%	1%	0%	1%
30%	-6%	2%	1%	0%	1%	1%	1%	2%	4%	3%	2%
40%	1%	0%	0%	1%	0%	1%	2%	2%	2%	2%	0%
50%	5%	3%	-1%	2%	1%	0%	-1%	2%	-1%	3%	2%
60%	5%	7%	1%	2%	2%	2%	0%	0%	0%	3%	2%
70%	3%	-1%	1%	2%	0%	-1%	-1%	0%	0%	0%	0%
80%	7%	4%	-2%	0%	1%	3%	2%	-1%	0%	-1%	0%
90%	13%	1%	3%	1%	2%	0%	1%	1%	-1%	1%	0%
100%	14%	4%	7%	8%	0%	4%	2%	0%	0%	0%	-1%

Table 53: Change in Type II Bank hedged income assuming 75 basis points expected drop in rates every year

Type II bank, in addition to net interest income, presents some fee-based income that is related to generation of loans and deposits. This fee-based income is called traditional and is generated through deposit and payment services, lending fees, and card fees. We simulate hedged income of our hypothetical bank under scenario of 75 basis points drop in rates every year during the five year time period. This table presents percentage changes in hedged income from change in rates. Our benchmark is income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
10%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
30%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
40%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
50%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
60%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
70%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
80%	-1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
100%	0%	-1%	-1%	0%	0%	0%	0%	0%	0%	0%	0%

Table 54: Change in standard deviation of Type II Bank hedged income assuming 75 basis points expected drop in rates every year

Type II bank, in addition to net interest income, presents some fee-based income that is related to generation of loans and deposits. This fee-based income is called traditional and is generated through deposit and payment services, lending fees, and card fees. We simulate hedged income of our hypothetical bank under scenario of 75 basis points drop in rates every year during the five year time period. This table presents percentage changes in standard deviation of hedged income from change in rates. Our benchmark is standard deviation of income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	-1%	-5%	0%	-2%	1%	5%	6%	5%	7%	1%	9%
10%	-4%	-3%	1%	0%	2%	1%	0%	0%	0%	3%	7%
20%	-3%	-1%	-3%	-2%	-2%	-1%	0%	-1%	-2%	-2%	3%
30%	0%	-2%	0%	-2%	-1%	-1%	-3%	0%	-4%	2%	0%
40%	-7%	-3%	-5%	-3%	-5%	-1%	-1%	-2%	-4%	2%	4%
50%	4%	-5%	-1%	-2%	-1%	-1%	-2%	-2%	-1%	0%	0%
60%	-4%	4%	-6%	1%	-2%	-3%	-1%	-2%	0%	-2%	-2%
70%	2%	-1%	-3%	-4%	-5%	0%	-3%	0%	-2%	-2%	-4%
80%	-8%	7%	-5%	4%	-4%	-1%	-3%	-2%	-1%	-2%	-2%
90%	-2%	5%	4%	-5%	-1%	0%	-3%	-3%	-1%	-4%	-2%
100%	-2%	-8%	-7%	0%	-3%	-1%	-1%	0%	-1%	-2%	-1%

Table 55: Type III Bank income

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. In this table we present an average dollar value of five-year income simulated under stable economy condition with no change in the interest rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0%	$2,922,913,331	$2,952,180,331	$2,984,226,908	$3,012,269,324	$3,041,101,032	$3,076,563,071	$3,104,594,744	$3,132,072,620	$3,166,923,206	$3,197,684,471	$3,219,848,085
10%	$3,028,908,972	$3,061,048,853	$3,089,425,022	$3,121,770,662	$3,150,750,917	$3,182,228,146	$3,213,838,847	$3,240,884,225	$3,270,351,989	$3,298,091,027	$3,329,886,837
20%	$3,141,295,176	$3,166,971,186	$3,199,640,558	$3,227,650,948	$3,259,048,844	$3,290,731,963	$3,320,211,912	$3,350,071,296	$3,381,722,147	$3,410,288,356	$3,438,635,193
30%	$3,242,266,118	$3,274,814,505	$3,306,550,427	$3,334,940,621	$3,365,072,332	$3,396,489,886	$3,426,495,520	$3,457,498,602	$3,490,554,472	$3,521,917,396	$3,552,950,716
40%	$3,352,494,518	$3,383,536,378	$3,414,974,466	$3,443,240,837	$3,473,859,337	$3,503,328,464	$3,534,411,867	$3,563,904,997	$3,594,849,569	$3,621,776,104	$3,653,161,407
50%	$3,457,289,075	$3,487,512,175	$3,519,621,515	$3,551,495,562	$3,581,631,111	$3,610,405,860	$3,642,086,960	$3,670,402,890	$3,700,202,706	$3,732,627,722	$3,762,561,572
60%	$3,566,816,560	$3,591,238,161	$3,629,044,393	$3,655,016,254	$3,688,338,947	$3,719,912,195	$3,748,607,672	$3,779,496,369	$3,809,506,694	$3,839,170,727	$3,872,432,576
70%	$3,675,256,446	$3,702,985,207	$3,739,314,889	$3,766,114,292	$3,795,673,248	$3,824,726,295	$3,856,254,752	$3,886,731,795	$3,917,644,414	$3,948,259,631	$3,977,794,085
80%	$3,771,918,163	$3,812,722,610	$3,839,654,466	$3,868,464,407	$3,900,242,767	$3,931,387,648	$3,965,153,157	$3,993,917,321	$4,024,442,620	$4,056,662,314	$4,083,941,410
90%	$3,884,361,077	$3,921,404,240	$3,944,089,365	$3,981,275,875	$4,011,172,612	$4,037,039,480	$4,071,510,008	$4,101,522,761	$4,131,882,767	$4,162,387,767	$4,193,202,445
100%	$3,999,678,959	$4,033,693,575	$4,062,695,948	$4,089,113,181	$4,117,455,235	$4,146,766,074	$4,178,355,099	$4,178,677,762	$4,238,550,490	$4,269,157,459	$4,300,745,707

Table 56: Average standard deviation of Type III Bank income

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. This table shows dollar values of standard deviations of bank income across five years. We simulate income for five years and calculate standard deviation of those incomes. As we run simulation 100 times, we calculate the average standard deviation and report it in this table. Standard deviation is different for every balance sheet structure. We present 121 various balance sheet structures, where fixed assets can vary from 0% to 100% and fixed rate liabilities can also vary from 0% to 100%.

Fixed Assets/Liabilities	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0%	$130,050,750	$140,795,462	$149,361,774	$159,332,930	$166,147,722	$181,726,030	$190,363,720	$199,969,835	$212,454,300	$223,010,916	$228,740,006
10%	$131,749,681	$142,854,407	$153,098,982	$164,246,290	$172,882,727	$183,816,656	$195,409,956	$202,201,314	$213,905,846	$222,985,502	$232,582,470
20%	$138,201,819	$146,362,437	$157,963,285	$167,944,992	$178,293,570	$188,920,807	$198,728,213	$209,215,272	$219,508,384	$229,345,507	$238,611,080
30%	$139,673,749	$150,242,630	$162,763,903	$170,508,643	$181,059,934	$192,329,812	$202,051,815	$212,595,263	$224,296,209	$236,436,233	$246,095,402
40%	$144,971,279	$155,546,230	$166,686,976	$175,861,833	$185,963,864	$195,967,440	$205,939,966	$216,568,394	$227,525,533	$234,477,796	$245,892,608
50%	$149,124,734	$159,412,876	$168,939,799	$179,588,648	$190,357,862	$198,798,006	$209,745,557	$219,153,372	$229,253,828	$240,402,570	$250,300,714
60%	$153,949,902	$158,826,492	$174,238,252	$181,121,726	$193,082,873	$204,337,250	$214,067,999	$223,567,565	$234,141,615	$244,267,695	$255,405,447
70%	$160,030,095	$166,247,930	$181,735,625	$188,270,054	$197,415,365	$208,075,034	$217,467,140	$227,854,381	$237,888,884	$249,634,281	$258,662,737
80%	$155,055,100	$173,248,236	$179,666,702	$189,586,753	$200,470,746	$210,272,923	$222,529,458	$232,106,693	$242,194,837	$253,496,658	$261,111,068
90%	$161,537,255	$177,225,464	$181,960,573	$196,742,691	$206,583,856	$212,918,408	$226,126,940	$235,769,076	$245,331,316	$256,422,084	$266,157,094
100%	$175,034,759	$184,778,828	$196,497,573	$201,828,938	$209,062,105	$219,553,647	$230,067,732	$230,674,833	$249,898,631	$260,507,073	$270,697,830

Table 57: Change in Type III Bank income assuming 25 basis points expected rise in rates every year

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. We simulate income of our hypothetical bank under scenario of 25 basis points rise in rates every year during the five year time period. This table presents percentage changes in income from change in rates. Our benchmark is income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	0%	1%	1%	2%	3%	3%	4%	4%	5%	5%	6%
10%	0%	0%	1%	1%	2%	3%	3%	4%	4%	5%	5%
20%	-1%	0%	0%	1%	1%	2%	2%	3%	3%	4%	4%
30%	-1%	-1%	0%	0%	1%	1%	2%	2%	3%	3%	4%
40%	-2%	-1%	-1%	0%	0%	1%	1%	2%	2%	3%	3%
50%	-2%	-2%	-1%	-1%	0%	0%	1%	1%	2%	2%	3%
60%	-3%	-2%	-2%	-1%	-1%	0%	0%	1%	1%	2%	2%
70%	-3%	-3%	-2%	-2%	-1%	-1%	0%	0%	1%	1%	2%
80%	-4%	-3%	-2%	-2%	-2%	-1%	-1%	0%	0%	1%	1%
90%	-4%	-4%	-3%	-3%	-2%	-2%	-1%	-1%	0%	0%	1%
100%	-4%	-4%	-3%	-3%	-2%	-2%	-2%	-1%	-1%	0%	0%

Table 58: Change in standard deviation of Type III Bank income assuming 25 basis points expected rise in rates every year

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. We simulate income of our hypothetical bank under scenario of 25 basis points rise in rates every year during the five year time period. This table presents percentage changes in standard deviation of income from change in rates. Our benchmark is standard deviation of income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	16%	19%	25%	27%	32%	33%	34%	35%	37%	39%	42%
10%	11%	16%	19%	21%	25%	29%	28%	34%	34%	40%	39%
20%	2%	9%	13%	17%	19%	22%	25%	30%	30%	32%	33%
30%	3%	4%	8%	12%	16%	19%	21%	24%	27%	27%	29%
40%	-4%	0%	2%	7%	11%	14%	17%	19%	21%	27%	27%
50%	-8%	-7%	2%	3%	7%	11%	14%	17%	19%	21%	24%
60%	-14%	-9%	-6%	0%	3%	6%	10%	13%	15%	18%	19%
70%	-21%	-12%	-12%	-5%	-1%	2%	6%	9%	12%	14%	17%
80%	-21%	-18%	-10%	-6%	-3%	0%	2%	6%	9%	10%	14%
90%	-19%	-22%	-15%	-12%	-9%	-4%	0%	3%	6%	7%	11%
100%	-27%	-27%	-20%	-16%	-10%	-6%	-5%	-4%	2%	5%	7%

Table 59: Change in Type III Bank income assuming 75 basis points expected rise in rates every year

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. We simulate income of our hypothetical bank under scenario of 75 basis points rise in rates every year during the five year time period. This table presents percentage changes in income from change in rates. Our benchmark is income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	1%	3%	4%	6%	8%	9%	11%	13%	14%	16%	18%
10%	-1%	1%	3%	4%	6%	8%	9%	11%	12%	14%	15%
20%	-3%	-1%	1%	2%	4%	6%	7%	9%	10%	12%	13%
30%	-4%	-2%	-1%	1%	2%	4%	5%	7%	8%	9%	11%
40%	-6%	-4%	-2%	-1%	1%	2%	4%	5%	7%	8%	9%
50%	-7%	-5%	-4%	-2%	-1%	1%	2%	4%	5%	7%	8%
60%	-8%	-7%	-5%	-4%	-2%	-1%	1%	2%	3%	5%	6%
70%	-9%	-8%	-7%	-5%	-4%	-2%	-1%	1%	2%	3%	5%
80%	-10%	-9%	-8%	-6%	-5%	-3%	-2%	-1%	1%	2%	3%
90%	-12%	-10%	-9%	-7%	-6%	-4%	-3%	-2%	-1%	1%	2%
100%	-13%	-11%	-10%	-9%	-7%	-6%	-4%	-4%	-2%	-1%	1%

Table 60: Change in standard deviation of Type III Bank income assuming 75 basis points expected rise in rates every year

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. We simulate income of our hypothetical bank under scenario of 75 basis points rise in rates every year during the five year time period. This table presents percentage changes in standard deviation of income from change in rates. Our benchmark is standard deviation of income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	49%	59%	72%	80%	94%	95%	104%	111%	113%	117%	129%
10%	35%	46%	55%	65%	77%	83%	89%	96%	103%	111%	113%
20%	16%	30%	40%	50%	60%	67%	74%	85%	91%	96%	103%
30%	4%	16%	26%	37%	48%	55%	64%	72%	78%	79%	89%
40%	-12%	2%	13%	24%	34%	43%	52%	59%	67%	76%	80%
50%	-19%	-10%	-1%	12%	21%	32%	41%	50%	57%	64%	69%
60%	-22%	-17%	-10%	4%	11%	20%	30%	38%	45%	53%	59%
70%	-33%	-29%	-22%	-8%	1%	10%	19%	28%	36%	43%	50%
80%	-29%	-36%	-30%	-19%	-8%	1%	8%	18%	26%	33%	42%
90%	-35%	-42%	-31%	-29%	-19%	-7%	1%	8%	17%	24%	31%
100%	-37%	-40%	-41%	-33%	-26%	-16%	-7%	-8%	8%	15%	23%

Table 61: Change in Type III Bank income assuming 75 basis points expected drop in rates every year

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. We simulate income of our hypothetical bank under scenario of 75 basis points drop in rates every year during the five year time period. This table presents percentage changes in income from change in rates. Our benchmark is income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	-1%	-3%	-5%	-6%	-8%	-10%	-11%	-13%	-14%	-16%	-17%
10%	1%	-1%	-3%	-4%	-6%	-7%	-9%	-11%	-12%	-13%	-15%
20%	2%	1%	-1%	-2%	-4%	-6%	-7%	-9%	-10%	-12%	-13%
30%	4%	2%	1%	-1%	-2%	-4%	-5%	-7%	-9%	-10%	-11%
40%	6%	4%	2%	1%	-1%	-2%	-4%	-5%	-7%	-8%	-9%
50%	7%	5%	4%	2%	1%	-1%	-2%	-4%	-5%	-6%	-8%
60%	8%	7%	5%	4%	2%	1%	-1%	-2%	-3%	-5%	-6%
70%	10%	8%	6%	5%	4%	2%	1%	-1%	-2%	-3%	-5%
80%	11%	9%	8%	6%	5%	3%	2%	1%	-1%	-2%	-3%
90%	12%	10%	9%	7%	6%	5%	3%	2%	1%	-1%	-2%
100%	13%	11%	10%	8%	7%	6%	4%	5%	2%	1%	-1%

Table 62: Change in standard deviation of Type III Bank income assuming 75 basis points expected drop in rates every year

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. We simulate income of our hypothetical bank under scenario of 75 basis points drop in rates every year during the five year time period. This table presents percentage changes in standard deviation of income from change in rates. Our benchmark is standard deviation of income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	-47%	-59%	-70%	-78%	-83%	-87%	-85%	-81%	-78%	-71%	-72%
10%	-28%	-43%	-55%	-63%	-74%	-79%	-84%	-85%	-86%	-82%	-78%
20%	-11%	-25%	-38%	-50%	-60%	-68%	-75%	-81%	-85%	-86%	-85%
30%	6%	-11%	-25%	-35%	-46%	-56%	-63%	-72%	-77%	-81%	-85%
40%	24%	5%	-11%	-23%	-33%	-44%	-52%	-61%	-67%	-73%	-78%
50%	35%	19%	5%	-9%	-21%	-31%	-41%	-50%	-55%	-64%	-69%
60%	44%	38%	15%	5%	-9%	-20%	-29%	-37%	-45%	-54%	-59%
70%	62%	48%	29%	15%	4%	-9%	-19%	-28%	-36%	-43%	-52%
80%	82%	52%	43%	26%	16%	4%	-7%	-17%	-27%	-34%	-41%
90%	87%	70%	56%	35%	25%	16%	3%	-7%	-16%	-24%	-32%
100%	94%	74%	56%	47%	36%	23%	11%	14%	-8%	-16%	-23%

Table 63: Change in Type III Bank hedged income assuming 75 basis points expected rise in rates every year

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. We simulate hedged income of our hypothetical bank under scenario of 75 basis points rise in rates every year during the five year time period. This table presents percentage changes in hedged income from change in rates. Our benchmark is income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
10%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
30%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
40%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
50%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
60%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
70%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
80%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table 64: Change in standard deviation of Type III Bank hedged income assuming 75 basis points expected rise in rates every year

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. We simulate hedged income of our hypothetical bank under scenario of 75 basis points rise in rates every year during the five year time period. This table presents percentage changes in standard deviation of hedged income from change in rates. Our benchmark is standard deviation of income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	0%	1%	0%	2%	3%	4%	4%	0%	-1%	5%	3%
10%	-1%	0%	2%	1%	1%	1%	2%	5%	4%	5%	4%
20%	1%	2%	0%	1%	1%	1%	4%	-2%	2%	2%	2%
30%	-1%	0%	0%	3%	1%	0%	0%	0%	0%	5%	2%
40%	2%	0%	0%	-1%	1%	0%	0%	0%	0%	1%	1%
50%	-3%	3%	3%	0%	1%	1%	0%	-1%	1%	0%	2%
60%	-2%	3%	1%	-3%	1%	1%	-1%	1%	1%	0%	-2%
70%	6%	2%	4%	1%	0%	0%	0%	0%	1%	0%	2%
80%	5%	9%	1%	1%	-1%	0%	0%	1%	0%	0%	0%
90%	6%	10%	2%	2%	2%	-2%	-1%	1%	0%	0%	0%
100%	14%	5%	2%	1%	2%	2%	-2%	-1%	0%	0%	1%

Table 65: Change in Type III Bank hedged income assuming 75 basis points expected drop in rates every year

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. We simulate hedged income of our hypothetical bank under scenario of 75 basis points drop in rates every year during the five year time period. This table presents percentage changes in hedged income from change in rates. Our benchmark is income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
10%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
30%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%	0%
40%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
50%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
60%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
70%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
80%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table 66: Change in standard deviation of Type III Bank hedged income assuming 75 basis points expected drop in rates every year

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. We simulate hedged income of our hypothetical bank under scenario of 75 basis points drop in rates every year during the five year time period. This table presents percentage changes in standard deviation of hedged income from change in rates. Our benchmark is standard deviation of income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	-3%	-4%	0%	-2%	5%	-1%	2%	1%	0%	1%	8%
10%	0%	-1%	-1%	-2%	2%	-1%	0%	3%	1%	7%	5%
20%	-1%	-3%	-3%	-2%	0%	-2%	-3%	1%	-1%	1%	2%
30%	1%	0%	-3%	-1%	-1%	-1%	-1%	0%	-1%	-8%	0%
40%	-5%	0%	-3%	-3%	-3%	-1%	-1%	-1%	0%	0%	-1%
50%	-2%	0%	-1%	-2%	-3%	-1%	0%	1%	1%	-1%	-1%
60%	5%	4%	-4%	5%	-1%	-4%	-2%	-1%	-1%	-1%	-2%
70%	-4%	0%	-7%	1%	-1%	-2%	-2%	-2%	-2%	-1%	-2%
80%	8%	-4%	-1%	0%	3%	-1%	-3%	-3%	-2%	-4%	0%
90%	8%	-2%	7%	-4%	-2%	3%	0%	-2%	-1%	-2%	-2%
100%	-4%	-2%	-2%	0%	2%	-1%	1%	-1%	-1%	-2%	-2%

Table 67: Type III Bank EBIT

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. We deduct costs associated with non-traditional services from Type III bank income and simulate earnings before interest and taxes (EBIT). In this table we present an average dollar value of five-year EBIT simulated under stable economy condition with no change in the interest rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0%	$1,581,237,982	$1,612,525,329	$1,642,368,711	$1,674,294,338	$1,703,107,091	$1,731,473,546	$1,761,157,770	$1,792,552,933	$1,829,495,409	$1,854,538,413	$1,880,981,829
10%	$1,688,264,557	$1,720,161,617	$1,749,145,514	$1,780,503,625	$1,811,119,221	$1,840,400,237	$1,871,467,487	$1,900,556,830	$1,933,375,027	$1,965,742,368	$1,993,513,483
20%	$1,794,999,560	$1,825,998,743	$1,857,773,728	$1,886,766,233	$1,916,989,102	$1,947,642,973	$1,978,683,964	$2,007,602,243	$2,038,859,733	$2,072,790,682	$2,106,298,927
30%	$1,901,404,726	$1,935,958,751	$1,963,472,739	$1,994,373,862	$2,025,055,676	$2,056,999,587	$2,085,099,347	$2,116,859,502	$2,145,000,106	$2,174,613,497	$2,209,390,196
40%	$2,008,371,799	$2,042,357,860	$2,069,105,590	$2,100,278,102	$2,132,497,680	$2,162,214,847	$2,192,121,300	$2,223,613,155	$2,255,447,761	$2,285,588,544	$2,320,711,049
50%	$2,118,749,911	$2,146,672,233	$2,181,211,301	$2,210,632,650	$2,239,963,748	$2,270,681,848	$2,301,049,982	$2,331,790,294	$2,358,833,587	$2,390,118,879	$2,420,848,173
60%	$2,223,632,102	$2,258,112,306	$2,286,137,006	$2,314,291,971	$2,348,413,741	$2,377,745,148	$2,408,485,445	$2,437,484,751	$2,467,716,843	$2,503,014,456	$2,530,578,748
70%	$2,333,870,492	$2,364,525,994	$2,393,937,688	$2,420,839,456	$2,454,310,278	$2,483,664,892	$2,515,980,035	$2,545,447,139	$2,577,081,077	$2,608,428,984	$2,636,527,433
80%	$2,436,182,233	$2,470,559,529	$2,499,975,898	$2,533,046,726	$2,562,865,263	$2,590,171,505	$2,624,079,270	$2,652,713,797	$2,683,647,748	$2,713,329,508	$2,746,619,953
90%	$2,549,192,008	$2,580,010,734	$2,604,109,694	$2,642,805,604	$2,672,091,464	$2,699,258,403	$2,730,373,619	$2,759,463,401	$2,791,233,792	$2,820,299,444	$2,851,856,729
100%	$2,652,099,142	$2,679,024,434	$2,712,236,040	$2,744,970,667	$2,778,170,695	$2,806,619,027	$2,837,441,941	$2,835,726,801	$2,897,912,910	$2,928,204,097	$2,958,482,093

Table 68: Average standard deviation of Type III Bank EBIT

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. We deduct costs associated with non-traditional services from Type III bank income and simulate earnings before interest and taxes (EBIT). In this table we present an average standard deviation of five-year EBIT simulated under stable economy condition with no change in the interest rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0%	$128,917,137	$139,435,395	$149,444,093	$160,828,625	$169,924,442	$177,792,857	$188,477,971	$200,251,882	$214,257,831	$222,060,767	$229,483,844
10%	$132,814,849	$143,232,465	$151,035,688	$163,175,830	$173,586,124	$183,976,027	$196,782,124	$204,332,904	$214,931,317	$227,534,586	$236,700,837
20%	$135,183,642	$146,429,925	$157,938,792	$166,937,851	$176,235,350	$186,961,562	$198,813,937	$208,419,519	$217,853,715	$230,825,080	$243,404,866
30%	$141,075,807	$152,058,100	$159,668,272	$170,266,783	$181,685,026	$191,938,151	$201,061,093	$212,543,893	$221,274,332	$231,441,403	$245,168,373
40%	$141,562,330	$156,003,831	$164,185,936	$173,779,261	$185,931,271	$195,194,126	$205,776,848	$215,998,385	$228,841,851	$237,767,145	$252,438,161
50%	$149,171,167	$157,636,680	$169,655,748	$179,387,304	$189,180,896	$200,630,702	$209,410,101	$220,065,729	$228,097,059	$239,667,491	$250,063,240
60%	$151,672,763	$164,737,028	$173,429,081	$180,177,295	$193,772,238	$203,574,213	$213,648,413	$223,436,012	$233,879,442	$247,986,555	$256,373,912
70%	$158,331,756	$170,663,314	$177,683,279	$184,321,022	$197,795,790	$206,762,978	$218,245,608	$227,933,275	$239,186,080	$249,647,683	$258,597,603
80%	$157,447,041	$171,495,470	$181,284,062	$192,995,090	$203,203,414	$209,586,158	$223,480,472	$231,566,767	$242,022,739	$251,912,375	$264,272,718
90%	$169,938,341	$176,467,667	$183,011,621	$198,905,781	$206,092,584	$215,768,007	$225,283,076	$235,545,779	$246,316,801	$255,993,300	$266,830,018
100%	$164,407,568	$170,941,478	$187,717,406	$198,737,865	$210,716,238	$219,448,624	$229,535,220	$228,179,858	$249,959,900	$259,511,188	$269,956,611

Table 69: Change in Type III Bank EBIT assuming 25 basis points expected rise in rates every year

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. We deduct costs associated with non-traditional services from Type III bank income and simulate earnings before interest and taxes (EBIT).We simulate EBIT of our hypothetical bank under scenario of 25 basis points rise in rates every year during the five year time period. This table presents percentage changes in EBIT from change in rates. Our benchmark is EBIT in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	1%	2%	3%	4%	5%	6%	7%	8%	8%	9%	10%
10%	0%	0%	2%	2%	4%	4%	5%	6%	7%	7%	8%
20%	-1%	0%	0%	1%	2%	3%	4%	5%	6%	6%	7%
30%	-2%	-2%	-1%	0%	1%	2%	3%	4%	4%	5%	6%
40%	-3%	-2%	-1%	0%	0%	1%	2%	3%	4%	4%	5%
50%	-4%	-3%	-2%	-1%	0%	0%	1%	2%	3%	3%	4%
60%	-4%	-4%	-3%	-2%	-1%	0%	0%	1%	2%	2%	3%
70%	-5%	-4%	-3%	-2%	-2%	-1%	0%	0%	1%	2%	2%
80%	-5%	-5%	-4%	-3%	-2%	-2%	-1%	0%	0%	1%	2%
90%	-6%	-5%	-4%	-4%	-3%	-2%	-2%	-1%	0%	0%	1%
100%	-6%	-6%	-5%	-4%	-4%	-3%	-2%	-2%	-1%	0%	0%

Table 70: Change in standard deviation of Type III Bank EBIT assuming 25 basis points expected rise in rates every year

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. We deduct costs associated with non-traditional services from Type III bank income and simulate earnings before interest and taxes (EBIT). We simulate EBIT of our hypothetical bank under scenario of 25 basis points rise in rates every year during the five year time period. This table presents percentage changes in standard deviation of EBIT from change in rates. Our benchmark is standard deviation of EBIT in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	15%	20%	24%	26%	29%	35%	34%	38%	35%	40%	43%
10%	12%	15%	21%	22%	26%	29%	28%	33%	33%	34%	37%
20%	10%	11%	11%	17%	21%	24%	24%	28%	29%	31%	32%
30%	1%	3%	9%	13%	15%	18%	21%	24%	26%	27%	27%
40%	-2%	-1%	5%	11%	11%	15%	17%	19%	22%	25%	25%
50%	-9%	-4%	-1%	4%	7%	10%	14%	16%	20%	20%	25%
60%	-13%	-7%	-5%	0%	4%	6%	10%	13%	14%	16%	20%
70%	-19%	-12%	-7%	-2%	-1%	4%	6%	9%	12%	14%	15%
80%	-19%	-16%	-11%	-10%	-4%	1%	2%	6%	9%	11%	13%
90%	-27%	-21%	-15%	-12%	-7%	-3%	-1%	3%	5%	8%	10%
100%	-25%	-23%	-18%	-14%	-10%	-8%	-3%	-4%	2%	5%	8%

Table 71: Change in Type III Bank EBIT assuming 75 basis points expected rise in rates every year

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. We deduct costs associated with non-traditional services from Type III bank income and simulate earnings before interest and taxes (EBIT).We simulate EBIT of our hypothetical bank under scenario of 75 basis points rise in rates every year during the five year time period. This table presents percentage changes in EBIT from change in rates. Our benchmark is EBIT in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	2%	5%	8%	11%	14%	17%	20%	22%	25%	28%	30%
10%	-2%	1%	4%	7%	10%	13%	16%	18%	20%	23%	26%
20%	-4%	-1%	1%	4%	7%	9%	12%	14%	17%	19%	21%
30%	-7%	-4%	-1%	1%	4%	6%	9%	11%	14%	16%	18%
40%	-9%	-7%	-4%	-1%	1%	4%	6%	8%	11%	12%	15%
50%	-11%	-9%	-6%	-4%	-1%	1%	3%	6%	8%	10%	12%
60%	-13%	-11%	-8%	-6%	-3%	-1%	1%	3%	5%	7%	9%
70%	-15%	-12%	-10%	-8%	-6%	-3%	-1%	1%	3%	5%	7%
80%	-16%	-14%	-12%	-10%	-7%	-5%	-3%	-1%	1%	3%	5%
90%	-18%	-16%	-13%	-11%	-9%	-7%	-5%	-3%	-1%	1%	3%
100%	-19%	-17%	-15%	-13%	-11%	-9%	-7%	-6%	-3%	-1%	1%

Table 72: Change in standard deviation of Type III Bank EBIT assuming 75 basis points expected rise in rates every year

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. We deduct costs associated with non-traditional services from Type III bank income and simulate earnings before interest and taxes (EBIT). We simulate EBIT of our hypothetical bank under scenario of 75 basis points rise in rates every year during the five year time period. This table presents percentage changes in standard deviation of EBIT from change in rates. Our benchmark is standard deviation of EBIT in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	51%	62%	73%	80%	90%	100%	106%	111%	114%	121%	129%
10%	32%	45%	58%	66%	75%	83%	87%	95%	101%	105%	114%
20%	20%	30%	40%	52%	61%	70%	75%	83%	90%	96%	98%
30%	-1%	14%	28%	38%	47%	55%	65%	71%	81%	86%	88%
40%	-5%	-1%	13%	25%	33%	44%	52%	60%	66%	72%	75%
50%	-19%	-8%	0%	12%	22%	32%	41%	49%	56%	64%	71%
60%	-25%	-18%	-8%	1%	10%	21%	29%	38%	46%	52%	58%
70%	-34%	-29%	-18%	-7%	1%	10%	19%	28%	35%	42%	50%
80%	-35%	-33%	-25%	-20%	-11%	1%	8%	18%	26%	33%	40%
90%	-37%	-40%	-30%	-29%	-21%	-10%	-1%	8%	17%	25%	31%
100%	-30%	-34%	-39%	-33%	-30%	-15%	-8%	-7%	8%	16%	24%

Table 73: Change in Type III Bank EBIT assuming 75 basis points expected drop in rates every year

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. We deduct costs associated with non-traditional services from Type III bank income and simulate earnings before interest and taxes (EBIT).We simulate EBIT of our hypothetical bank under scenario of 75 basis points drop in rates every year during the five year time period. This table presents percentage changes in EBIT from change in rates. Our benchmark is EBIT in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	-2%	-5%	-8%	-11%	-14%	-17%	-20%	-22%	-25%	-27%	-30%
10%	2%	-2%	-5%	-8%	-11%	-13%	-16%	-18%	-21%	-24%	-26%
20%	4%	1%	-1%	-4%	-7%	-10%	-12%	-15%	-17%	-19%	-22%
30%	7%	4%	1%	-1%	-4%	-7%	-9%	-12%	-14%	-16%	-18%
40%	9%	7%	4%	1%	-1%	-4%	-6%	-9%	-11%	-13%	-15%
50%	11%	9%	6%	4%	1%	-1%	-4%	-6%	-8%	-10%	-12%
60%	13%	10%	8%	6%	3%	1%	-1%	-3%	-5%	-8%	-10%
70%	15%	12%	10%	8%	5%	3%	1%	-1%	-3%	-5%	-7%
80%	17%	14%	12%	9%	7%	5%	3%	1%	-1%	-3%	-5%
90%	18%	15%	14%	11%	9%	7%	5%	3%	1%	-1%	-3%
100%	19%	17%	15%	13%	11%	9%	7%	7%	3%	1%	-1%

Table 74: Change in standard deviation of Type III Bank EBIT assuming 75 basis points expected drop in rates every year

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. We deduct costs associated with non-traditional services from Type III bank income and simulate earnings before interest and taxes (EBIT). We simulate EBIT of our hypothetical bank under scenario of 75 basis points drop in rates every year during the five year time period. This table presents percentage changes in standard deviation of EBIT from change in rates. Our benchmark is standard deviation of EBIT in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	-45%	-59%	-69%	-78%	-83%	-86%	-84%	-83%	-78%	-77%	-69%
10%	-29%	-42%	-53%	-65%	-74%	-80%	-84%	-85%	-85%	-80%	-81%
20%	-13%	-27%	-39%	-50%	-58%	-68%	-76%	-82%	-84%	-86%	-85%
30%	3%	-12%	-24%	-36%	-47%	-57%	-64%	-70%	-76%	-82%	-84%
40%	21%	4%	-11%	-22%	-32%	-43%	-53%	-61%	-67%	-73%	-78%
50%	36%	17%	4%	-8%	-21%	-31%	-41%	-50%	-57%	-63%	-69%
60%	48%	30%	17%	4%	-8%	-19%	-30%	-38%	-47%	-54%	-60%
70%	66%	40%	26%	15%	2%	-7%	-18%	-28%	-36%	-44%	-51%
80%	80%	55%	40%	25%	13%	5%	-8%	-17%	-27%	-33%	-43%
90%	82%	66%	54%	36%	24%	13%	1%	-8%	-17%	-25%	-32%
100%	98%	89%	62%	48%	34%	22%	14%	14%	-7%	-16%	-23%

Table 75: Change in Type III Bank hedged EBIT assuming 75 basis points expected rise in rates every year

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. We deduct costs associated with non-traditional services from Type III bank income and simulate earnings before interest and taxes (EBIT).We simulate hedged EBIT of our hypothetical bank under scenario of 75 basis points rise in rates every year during the five year time period. This table presents percentage changes in hedged EBIT from change in rates. Our benchmark is EBIT in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%	0%
10%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%
20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%	0%
30%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
40%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
50%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
60%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
70%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
80%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table 76: Change in standard deviation of Type III Bank hedged EBIT assuming 75 basis points expected rise in rates every year

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. We deduct costs associated with non-traditional services from Type III bank income and simulate earnings before interest and taxes (EBIT). We simulate hedged EBIT of our hypothetical bank under scenario of 75 basis points rise in rates every year during the five year time period. This table presents percentage changes in standard deviation of hedged EBIT from change in rates. Our benchmark is standard deviation of EBIT in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	0%	-2%	1%	1%	3%	3%	2%	2%	2%	0%	4%
10%	1%	0%	1%	0%	0%	0%	2%	4%	5%	5%	4%
20%	0%	1%	0%	0%	1%	1%	1%	1%	5%	-1%	4%
30%	5%	0%	-1%	1%	0%	2%	1%	-1%	0%	2%	2%
40%	-3%	1%	-1%	1%	0%	0%	0%	-1%	1%	4%	1%
50%	3%	-1%	1%	1%	1%	-1%	0%	2%	3%	3%	1%
60%	-3%	-1%	0%	3%	0%	0%	0%	1%	1%	-2%	2%
70%	2%	4%	-2%	0%	0%	0%	0%	0%	0%	1%	1%
80%	2%	1%	-1%	2%	0%	-1%	0%	0%	-1%	1%	-1%
90%	4%	1%	2%	1%	3%	2%	2%	0%	0%	0%	1%
100%	6%	5%	1%	0%	2%	-2%	-2%	-1%	1%	-1%	-1%

Table 77: Change in Type III Bank hedged EBIT assuming 75 basis points expected drop in rates every year

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. We deduct costs associated with non-traditional services from Type III bank income and simulate earnings before interest and taxes (EBIT).We simulate hedged EBIT of our hypothetical bank under scenario of 75 basis points drop in rates every year during the five year time period. This table presents percentage changes in hedged EBIT from change in rates. Our benchmark is EBIT in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%
10%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%
30%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
40%	0%	-1%	0%	0%	0%	0%	0%	0%	0%	0%	-1%
50%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
60%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
70%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
80%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
90%	0%	0%	0%	-1%	0%	0%	0%	0%	0%	0%	0%
100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table 78: Change in standard deviation of Type III Bank hedged EBIT assuming 75 basis points expected drop in rates every year

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. We deduct costs associated with non-traditional services from Type III bank income and simulate earnings before interest and taxes (EBIT). We simulate hedged EBIT of our hypothetical bank under scenario of 75 basis points drop in rates every year during the five year time period. This table presents percentage changes in standard deviation of hedged EBIT from change in rates. Our benchmark is standard deviation of EBIT in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	0%	-2%	1%	-1%	2%	2%	5%	7%	2%	7%	9%
10%	-2%	-1%	0%	0%	-1%	-1%	-3%	0%	1%	1%	5%
20%	3%	0%	-3%	-1%	-1%	0%	-1%	-2%	-1%	2%	-2%
30%	-6%	-3%	0%	-1%	-2%	-1%	0%	1%	2%	0%	-1%
40%	6%	-6%	-3%	0%	-2%	1%	-1%	-1%	-1%	-2%	-4%
50%	-1%	0%	-3%	-3%	-2%	-1%	-1%	-1%	-1%	2%	2%
60%	6%	0%	0%	0%	-2%	-1%	-2%	-3%	-1%	-4%	-3%
70%	0%	1%	3%	3%	-2%	-2%	-3%	-1%	-3%	-4%	0%
80%	10%	3%	2%	-3%	-3%	1%	-4%	-2%	-1%	-3%	-1%
90%	0%	6%	5%	-6%	-4%	-2%	-2%	-2%	-2%	0%	-3%
100%	11%	15%	2%	-1%	-2%	2%	-1%	1%	-1%	-1%	-1%

Table 79: Type IV Bank income

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated trough investment management, underwriting services, and trading. In this table we present an average dollar value of five-year income simulated under stable economy condition with no change in the interest rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0%	$3,198,162,165	$3,247,062,640	$3,278,260,567	$3,296,079,989	$3,336,225,145	$3,365,361,584	$3,405,893,200	$3,440,522,439	$3,443,679,341	$3,466,262,514	$3,490,237,681
10%	$3,305,535,470	$3,350,135,857	$3,371,881,461	$3,388,149,340	$3,447,120,105	$3,493,592,527	$3,512,204,041	$3,528,302,112	$3,552,419,103	$3,587,959,538	$3,603,975,070
20%	$3,433,801,535	$3,462,628,734	$3,489,424,302	$3,498,273,077	$3,558,461,717	$3,567,403,748	$3,598,457,671	$3,634,337,035	$3,663,446,450	$3,684,140,754	$3,734,984,863
30%	$3,543,429,413	$3,575,246,663	$3,572,389,599	$3,635,605,209	$3,659,649,961	$3,677,333,159	$3,730,393,730	$3,738,418,067	$3,765,914,391	$3,829,785,175	$3,826,710,915
40%	$3,651,893,468	$3,657,204,877	$3,723,015,545	$3,715,859,718	$3,770,515,376	$3,783,154,593	$3,814,216,945	$3,848,239,560	$3,893,595,494	$3,895,831,804	$3,940,536,596
50%	$3,753,639,805	$3,759,392,916	$3,808,961,061	$3,847,363,375	$3,871,550,225	$3,874,327,250	$3,927,624,784	$3,927,996,311	$3,968,999,174	$4,026,215,774	$4,057,945,829
60%	$3,837,291,807	$3,876,830,522	$3,921,805,993	$3,955,851,076	$3,983,820,950	$4,000,542,233	$4,030,587,523	$4,045,433,755	$4,110,591,263	$4,125,187,509	$4,132,503,949
70%	$3,971,041,460	$4,009,412,143	$4,013,513,053	$4,049,170,310	$4,088,814,304	$4,114,358,258	$4,143,364,634	$4,188,194,040	$4,189,918,361	$4,236,541,638	$4,265,081,401
80%	$4,047,691,833	$4,097,150,802	$4,124,781,289	$4,139,173,707	$4,187,231,500	$4,224,459,151	$4,246,629,090	$4,261,685,661	$4,323,416,105	$4,350,439,474	$4,369,388,266
90%	$4,174,578,469	$4,167,462,349	$4,237,854,609	$4,271,819,857	$4,283,703,779	$4,322,403,587	$4,371,608,658	$4,392,497,251	$4,407,715,810	$4,447,416,464	$4,471,902,810
100%	$4,294,319,408	$4,316,757,161	$4,340,645,100	$4,405,573,331	$4,423,220,106	$4,436,527,332	$4,471,895,184	$4,454,512,627	$4,522,445,234	$4,568,964,352	$4,579,015,831

Table 80: Average standard deviation of Type IV Bank income

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated trough investment management, underwriting services, and trading. We simulate income for five years and calculate standard deviation of those incomes. As we run simulation 100 times, we calculate the average standard deviation and report it in this table. Standard deviation is different for every balance sheet structure. We present 121 various balance sheet structures, where fixed assets can vary from 0% to 100% and fixed rate liabilities can also vary from 0% to 100%.

Fixed Assets/Liabilities	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0%	$271,830,090	$274,531,234	$272,087,422	$271,377,210	$286,975,676	$283,936,860	$305,071,110	$300,623,643	$319,320,807	$322,715,666	$336,631,727
10%	$268,441,216	$294,915,713	$273,399,293	$288,134,498	$300,583,001	$292,188,795	$290,908,503	$318,500,452	$297,777,050	$325,838,310	$321,215,052
20%	$268,574,685	$274,298,593	$274,448,544	$288,648,436	$292,463,397	$301,639,790	$301,807,540	$289,582,898	$335,228,570	$311,827,857	$343,815,741
30%	$284,288,837	$283,848,538	$287,191,412	$283,457,170	$287,272,841	$286,647,112	$312,999,896	$310,110,425	$317,288,328	$328,265,689	$341,483,531
40%	$286,282,213	$277,365,555	$283,696,271	$292,561,056	$293,429,910	$292,651,069	$302,900,188	$313,021,600	$317,648,459	$325,949,157	$341,686,344
50%	$265,250,027	$288,233,952	$270,138,886	$295,164,100	$300,822,353	$304,883,439	$312,355,352	$308,603,626	$331,355,331	$330,733,017	$349,710,069
60%	$275,586,116	$286,309,040	$298,468,329	$279,177,185	$294,046,113	$318,688,545	$307,891,379	$318,214,940	$321,685,691	$324,391,766	$344,494,247
70%	$277,560,352	$300,757,588	$288,615,209	$297,140,741	$303,890,077	$309,245,744	$301,940,013	$299,666,861	$330,381,734	$336,094,042	$339,400,127
80%	$289,724,293	$296,966,577	$290,614,257	$310,369,279	$298,164,892	$305,448,456	$313,726,792	$317,453,741	$331,201,264	$348,594,039	$349,766,164
90%	$297,015,120	$275,481,221	$301,630,193	$290,128,792	$297,987,225	$300,677,884	$328,140,348	$318,991,847	$345,006,393	$325,928,046	$341,216,108
100%	$289,292,852	$292,602,150	$301,285,985	$302,306,625	$322,223,322	$328,832,871	$329,647,310	$325,610,999	$349,782,317	$330,853,006	$350,272,224

Table 81: Change in Type IV Bank income assuming 25 basis points expected rise in rates every year

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated trough investment management, underwriting services, and trading. We simulate income of our hypothetical bank under scenario of 25 basis points rise in rates every year during the five year time period. This table presents percentage changes in income from change in rates. Our benchmark is income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	0%	1%	1%	2%	2%	3%	2%	4%	5%	5%	6%
10%	0%	0%	1%	2%	2%	2%	3%	3%	4%	4%	6%
20%	0%	-1%	0%	1%	0%	2%	3%	3%	3%	4%	4%
30%	-1%	-1%	0%	0%	0%	1%	1%	2%	3%	2%	4%
40%	-3%	-1%	-1%	0%	0%	2%	2%	2%	2%	3%	3%
50%	-3%	-1%	-2%	-1%	0%	0%	0%	2%	2%	2%	2%
60%	-2%	-2%	-2%	-1%	-1%	0%	0%	1%	1%	2%	3%
70%	-3%	-3%	-2%	-1%	-1%	-1%	0%	0%	0%	1%	2%
80%	-3%	-3%	-3%	-1%	-1%	-1%	0%	0%	0%	0%	1%
90%	-4%	-2%	-3%	-2%	-2%	-1%	-1%	0%	0%	1%	0%
100%	-4%	-4%	-3%	-3%	-3%	-2%	-2%	-1%	-1%	-1%	0%

Table 82: Change in standard deviation of Type IV Bank income assuming 25 basis points expected rise in rates every year

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated trough investment management, underwriting services, and trading. We simulate income of our hypothetical bank under scenario of 25 basis points rise in rates every year during the five year time period. This table presents percentage changes in standard deviation of income from change in rates. Our benchmark is standard deviation of income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	2%	0%	7%	19%	12%	19%	11%	15%	18%	13%	19%
10%	4%	-3%	10%	2%	7%	10%	20%	9%	21%	19%	21%
20%	8%	2%	8%	3%	12%	12%	14%	28%	10%	23%	18%
30%	-5%	0%	5%	6%	10%	8%	11%	10%	17%	17%	9%
40%	-4%	-9%	7%	1%	6%	12%	17%	8%	13%	18%	16%
50%	6%	-7%	10%	2%	3%	10%	9%	9%	5%	10%	7%
60%	-5%	-8%	-5%	7%	7%	-2%	2%	6%	13%	12%	9%
70%	3%	-6%	3%	-2%	2%	4%	9%	11%	3%	13%	9%
80%	-4%	-8%	2%	-3%	-2%	2%	1%	3%	4%	2%	4%
90%	-9%	-3%	-9%	-3%	0%	2%	-2%	5%	-1%	10%	8%
100%	2%	-10%	-4%	-4%	-5%	-7%	-4%	-3%	-3%	6%	4%

Table 83: Change in Type IV Bank income assuming 75 basis points expected rise in rates every year

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated trough investment management, underwriting services, and trading. We simulate income of our hypothetical bank under scenario of 75 basis points rise in rates every year during the five year time period. This table presents percentage changes in income from change in rates. Our benchmark is income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	2%	2%	4%	6%	7%	8%	10%	11%	13%	15%	16%
10%	-1%	1%	3%	5%	6%	6%	7%	10%	12%	13%	14%
20%	-2%	-1%	1%	3%	3%	5%	7%	8%	9%	11%	12%
30%	-5%	-3%	0%	1%	2%	3%	5%	7%	8%	9%	11%
40%	-6%	-3%	-2%	0%	1%	2%	3%	5%	6%	8%	10%
50%	-7%	-4%	-4%	-2%	0%	1%	2%	4%	5%	6%	7%
60%	-7%	-6%	-5%	-3%	-2%	-1%	1%	3%	3%	4%	7%
70%	-9%	-8%	-6%	-5%	-4%	-2%	-1%	0%	2%	3%	4%
80%	-10%	-8%	-7%	-5%	-5%	-3%	-2%	0%	0%	2%	3%
90%	-11%	-8%	-8%	-7%	-5%	-4%	-4%	-2%	-1%	1%	2%
100%	-12%	-11%	-9%	-9%	-7%	-5%	-4%	-4%	-2%	-1%	1%

Table 84: Change in standard deviation of Type IV Bank income assuming 75 basis points expected rise in rates every year

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated trough investment management, underwriting services, and trading. We simulate income of our hypothetical bank under scenario of 75 basis points rise in rates every year during the five year time period. This table presents percentage changes in standard deviation of income from change in rates. Our benchmark is standard deviation of income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	10%	23%	30%	34%	37%	47%	42%	59%	54%	61%	63%
10%	12%	2%	20%	24%	32%	37%	49%	46%	71%	63%	73%
20%	5%	7%	15%	15%	22%	32%	29%	50%	39%	64%	55%
30%	-3%	-1%	5%	14%	32%	31%	28%	39%	43%	49%	48%
40%	-12%	0%	9%	7%	16%	30%	30%	31%	41%	41%	50%
50%	-3%	-12%	5%	3%	11%	14%	21%	25%	32%	34%	39%
60%	-4%	-12%	-7%	1%	2%	4%	16%	25%	25%	40%	30%
70%	-9%	-13%	1%	-6%	1%	6%	17%	27%	20%	22%	34%
80%	-14%	-14%	-9%	-9%	-2%	-1%	8%	14%	6%	18%	27%
90%	-14%	-10%	-12%	-1%	-3%	1%	0%	7%	3%	14%	24%
100%	-5%	-9%	-14%	-12%	-16%	-9%	-2%	-3%	6%	11%	21%

Table 85: Change in Type IV Bank income assuming 75 basis points expected drop in rates every year

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated trough investment management, underwriting services, and trading. We simulate income of our hypothetical bank under scenario of 75 basis points drop in rates every year during the five year time period. This table presents percentage changes in income from change in rates. Our benchmark is income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	0%	-2%	-4%	-5%	-7%	-8%	-11%	-12%	-13%	-15%	-15%
10%	1%	-1%	-3%	-3%	-6%	-8%	-9%	-10%	-11%	-13%	-14%
20%	2%	1%	-1%	-1%	-4%	-5%	-6%	-8%	-10%	-11%	-12%
30%	4%	2%	2%	-1%	-2%	-3%	-5%	-6%	-8%	-9%	-10%
40%	4%	5%	2%	1%	-1%	-2%	-3%	-4%	-6%	-8%	-9%
50%	6%	6%	3%	1%	0%	0%	-2%	-2%	-4%	-6%	-7%
60%	8%	5%	5%	3%	2%	1%	-1%	-1%	-3%	-4%	-5%
70%	8%	7%	7%	5%	3%	2%	1%	-1%	-2%	-3%	-5%
80%	11%	8%	7%	7%	5%	3%	2%	1%	-1%	-2%	-3%
90%	11%	10%	8%	7%	6%	4%	3%	1%	1%	-1%	-2%
100%	11%	11%	10%	7%	6%	6%	4%	5%	2%	0%	0%

Table 86: Change in standard deviation of Type IV Bank income assuming 75 basis points expected drop in rates every year

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated trough investment management, underwriting services, and trading. We simulate income of our hypothetical bank under scenario of 75 basis points drop in rates every year during the five year time period. This table presents percentage changes in standard deviation of income from change in rates. Our benchmark is standard deviation of income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	-7%	-17%	-17%	-13%	-17%	-16%	-22%	-20%	-24%	-25%	-28%
10%	0%	-16%	-13%	-13%	-16%	-22%	-23%	-26%	-17%	-23%	-24%
20%	-1%	-9%	-7%	-17%	-17%	-19%	-20%	-18%	-30%	-21%	-24%
30%	-7%	-4%	-5%	-10%	-13%	-15%	-25%	-21%	-23%	-27%	-28%
40%	2%	-4%	-3%	-4%	-6%	-9%	-14%	-17%	-24%	-29%	-25%
50%	17%	8%	9%	-6%	-9%	-2%	-16%	-15%	-20%	-25%	-30%
60%	14%	10%	0%	5%	-1%	-9%	-13%	-17%	-15%	-19%	-24%
70%	17%	6%	14%	3%	6%	-5%	-9%	-3%	-13%	-11%	-20%
80%	27%	14%	22%	2%	8%	-1%	-8%	-2%	-15%	-14%	-20%
90%	26%	26%	15%	20%	17%	9%	-4%	-3%	-6%	-8%	-15%
100%	29%	39%	24%	19%	15%	3%	-4%	8%	-5%	0%	-16%

Table 87: Change in Type IV Bank hedged income assuming 75 basis points expected rise in rates every year

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated trough investment management, underwriting services, and trading. We simulate hedged income of our hypothetical bank under scenario of 75 basis points rise in rates every year during the five year time period. This table presents percentage changes in hedged income from change in rates. Our benchmark is income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	-1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%
10%	0%	0%	0%	-1%	-1%	0%	1%	0%	-1%	0%	0%
20%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%
30%	0%	0%	1%	-1%	0%	1%	0%	0%	0%	-1%	0%
40%	0%	0%	-1%	-1%	0%	0%	0%	0%	0%	0%	-1%
50%	1%	-1%	0%	0%	-1%	0%	0%	0%	0%	0%	0%
60%	-1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%
70%	0%	0%	0%	0%	0%	0%	0%	1%	1%	-1%	0%
80%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	-1%
90%	1%	-1%	1%	0%	0%	0%	0%	0%	1%	0%	0%
100%	1%	0%	0%	0%	0%	0%	0%	0%	0%	-1%	1%

Table 88: Change in standard deviation of Type IV Bank hedged income assuming 75 basis points expected rise in rates every year

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated trough investment management, underwriting services, and trading. We simulate hedged income of our hypothetical bank under scenario of 75 basis points rise in rates every year during the five year time period. This table presents percentage changes in standard deviation of hedged income from change in rates. Our benchmark is standard deviation of income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	4%	5%	2%	3%	-6%	2%	15%	3%	5%	5%	5%
10%	0%	-3%	1%	1%	-2%	-1%	3%	0%	-1%	-3%	4%
20%	5%	2%	-5%	3%	-2%	2%	7%	8%	6%	1%	-1%
30%	-8%	1%	-1%	-4%	-4%	1%	-6%	1%	5%	3%	-3%
40%	-2%	3%	-7%	0%	0%	8%	-1%	1%	-5%	0%	2%
50%	7%	2%	9%	-7%	-3%	-2%	0%	7%	-4%	4%	-2%
60%	0%	2%	-6%	5%	6%	0%	-4%	-1%	-5%	1%	10%
70%	-3%	-4%	2%	0%	-5%	8%	2%	2%	-2%	7%	-4%
80%	-7%	9%	6%	-4%	0%	-5%	1%	-4%	6%	-7%	-7%
90%	6%	-4%	3%	-2%	5%	4%	-3%	-1%	0%	8%	0%
100%	11%	4%	3%	-2%	4%	-4%	-8%	-1%	-4%	7%	-2%

Table 89: Change in Type IV Bank hedged income assuming 75 basis points expected drop in rates every year

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated trough investment management, underwriting services, and trading. We simulate hedged income of our hypothetical bank under scenario of 75 basis points drop in rates every year during the five year time period. This table presents percentage changes in hedged income from change in rates. Our benchmark is income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	2%	-1%	0%	0%	1%	0%	-1%	-1%	0%	1%	1%
10%	1%	-1%	0%	1%	1%	-2%	-2%	0%	0%	0%	1%
20%	-1%	0%	0%	1%	-1%	0%	0%	0%	0%	1%	0%
30%	-1%	-1%	1%	-1%	-1%	0%	-1%	1%	0%	0%	0%
40%	-1%	1%	0%	1%	0%	0%	0%	0%	-1%	1%	1%
50%	0%	1%	-1%	0%	0%	1%	1%	2%	1%	0%	-1%
60%	0%	1%	-1%	0%	-1%	0%	0%	2%	0%	-1%	2%
70%	0%	-2%	-1%	0%	0%	0%	0%	-1%	1%	1%	-1%
80%	0%	0%	0%	1%	0%	0%	0%	1%	-1%	-1%	0%
90%	0%	2%	0%	0%	1%	0%	-1%	0%	0%	0%	0%
100%	-1%	0%	0%	-1%	-1%	0%	0%	0%	0%	-1%	0%

Table 90: Change in standard deviation of Type IV Bank hedged income assuming 75 basis points expected drop in rates every year

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated trough investment management, underwriting services, and trading. We simulate hedged income of our hypothetical bank under scenario of 75 basis points drop in rates every year during the five year time period. This table presents percentage changes in standard deviation of hedged income from change in rates. Our benchmark is standard deviation of income in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	-2%	-7%	10%	6%	4%	2%	-2%	11%	-1%	-9%	-2%
10%	-2%	-12%	-1%	-4%	3%	1%	10%	-5%	16%	2%	6%
20%	-1%	-3%	-6%	-4%	-1%	3%	0%	10%	-9%	9%	-4%
30%	6%	-6%	-5%	5%	3%	5%	-4%	-4%	0%	4%	-6%
40%	-1%	6%	-1%	1%	4%	6%	11%	2%	6%	6%	2%
50%	15%	2%	9%	4%	-2%	5%	6%	-1%	-8%	-7%	-5%
60%	3%	-9%	-3%	9%	2%	-9%	3%	2%	9%	12%	-3%
70%	9%	-5%	14%	-2%	1%	0%	11%	16%	-1%	-3%	3%
80%	5%	-6%	-2%	-7%	3%	6%	9%	-6%	0%	-3%	4%
90%	-4%	11%	4%	16%	3%	14%	-3%	3%	-7%	7%	-5%
100%	-3%	1%	-5%	1%	-12%	-9%	8%	-2%	0%	4%	8%

Table 91: Type IV Bank EBIT

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated through investment management, underwriting services, and trading. We deduct costs associated with non-traditional services from Type IV bank income and simulate earnings before interest and taxes (EBIT). In this table we present an average dollar value of five-year EBIT simulated under stable economy condition with no change in the interest rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0%	$1,267,718,438	$1,280,665,737	$1,293,625,944	$1,370,084,537	$1,371,705,696	$1,406,136,135	$1,452,794,774	$1,466,799,786	$1,494,282,507	$1,535,668,984	$1,569,713,996
10%	$1,363,659,542	$1,393,665,951	$1,421,748,447	$1,447,601,759	$1,487,445,224	$1,510,224,273	$1,533,184,809	$1,562,389,075	$1,590,359,934	$1,647,306,781	$1,676,665,609
20%	$1,472,139,465	$1,508,255,699	$1,513,846,209	$1,573,058,171	$1,612,567,501	$1,626,947,953	$1,641,569,785	$1,675,796,479	$1,726,673,630	$1,746,348,449	$1,796,917,935
30%	$1,558,296,421	$1,616,983,113	$1,636,142,818	$1,675,000,116	$1,696,974,117	$1,743,206,728	$1,738,442,066	$1,787,814,791	$1,827,919,308	$1,846,789,459	$1,856,941,667
40%	$1,678,580,410	$1,721,785,136	$1,751,093,007	$1,775,800,737	$1,809,616,799	$1,810,000,236	$1,866,143,860	$1,903,000,901	$1,945,215,332	$1,960,528,725	$1,987,016,052
50%	$1,794,450,964	$1,815,291,369	$1,839,574,526	$1,883,448,515	$1,919,402,078	$1,944,399,689	$1,956,493,562	$2,022,546,344	$2,021,721,801	$2,052,802,412	$2,112,528,256
60%	$1,879,798,096	$1,922,612,333	$1,940,016,943	$1,989,270,042	$2,001,597,413	$2,050,232,261	$2,082,260,704	$2,113,737,215	$2,142,789,473	$2,186,464,401	$2,213,499,255
70%	$1,991,051,444	$2,039,098,632	$2,046,356,153	$2,103,185,686	$2,114,989,468	$2,167,789,011	$2,192,379,350	$2,205,944,510	$2,256,310,749	$2,296,958,086	$2,321,835,541
80%	$2,131,580,200	$2,130,262,105	$2,198,122,025	$2,186,319,561	$2,223,285,932	$2,268,118,086	$2,272,118,298	$2,336,522,537	$2,354,084,809	$2,372,535,949	$2,423,403,562
90%	$2,213,900,871	$2,247,780,579	$2,268,020,716	$2,302,638,126	$2,347,992,596	$2,379,109,028	$2,392,258,280	$2,429,476,998	$2,451,368,291	$2,491,203,636	$2,524,779,040
100%	$2,324,126,922	$2,347,730,933	$2,384,806,538	$2,413,785,679	$2,449,353,403	$2,472,303,434	$2,521,894,800	$2,488,190,891	$2,567,849,389	$2,596,550,736	$2,650,313,632

Table 92: Average standard deviation of Type IV Bank EBIT

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated trough investment management, underwriting services, and trading. We deduct costs associated with non-traditional services from Type IV bank income and simulate earnings before interest and taxes (EBIT). In this table we present an average standard deviation of five-year EBIT simulated under stable economy condition with no change in the interest rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0%	$239,457,116	$227,831,564	$222,046,775	$230,755,672	$248,820,606	$249,748,943	$256,641,497	$231,267,617	$248,834,896	$249,169,419	$255,345,622
10%	$226,109,336	$235,857,302	$226,478,964	$223,087,201	$227,459,110	$248,673,348	$242,069,730	$245,609,667	$238,325,398	$236,872,999	$257,439,005
20%	$234,614,606	$235,095,875	$244,590,216	$235,748,422	$258,232,251	$245,905,783	$239,821,677	$235,816,695	$252,988,119	$251,080,358	$261,631,584
30%	$232,095,705	$227,307,470	$232,256,504	$231,332,492	$234,735,103	$238,887,441	$248,491,269	$246,411,481	$242,650,312	$252,916,177	$246,322,760
40%	$251,285,542	$245,760,312	$232,761,323	$240,745,428	$240,750,462	$226,517,699	$246,610,120	$236,839,978	$250,558,329	$245,187,080	$261,796,900
50%	$241,471,931	$236,980,881	$238,381,600	$241,542,307	$243,022,186	$239,583,141	$233,188,825	$239,814,029	$247,144,290	$255,525,864	$253,994,250
60%	$219,055,071	$249,995,771	$236,905,356	$223,047,872	$239,435,810	$240,862,427	$246,897,755	$243,554,924	$261,886,349	$257,589,989	$255,838,862
70%	$248,400,739	$253,298,452	$239,262,280	$225,980,921	$242,118,170	$230,238,793	$239,923,074	$246,935,572	$243,353,073	$259,723,174	$268,590,166
80%	$239,173,787	$244,052,249	$236,098,293	$249,115,096	$236,942,432	$249,620,439	$257,519,825	$233,745,776	$250,799,900	$247,329,983	$257,640,025
90%	$234,561,902	$235,495,390	$243,130,965	$232,898,387	$249,997,338	$234,935,467	$235,798,365	$246,489,062	$257,854,269	$264,291,684	$263,817,534
100%	$235,983,692	$226,919,770	$247,301,430	$242,231,649	$239,338,336	$240,455,394	$248,076,014	$236,738,948	$244,317,937	$253,744,950	$251,568,934

Table 93: Change in Type IV Bank EBIT assuming 25 basis points expected rise in rates every year

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated trough investment management, underwriting services, and trading. We simulate EBIT of our hypothetical bank under scenario of 25 basis points rise in rates every year during the five year time period. This table presents percentage changes in EBIT from change in rates. Our benchmark is EBIT in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	0%	3%	4%	3%	8%	6%	7%	9%	11%	10%	10%
10%	-2%	-1%	2%	4%	4%	4%	6%	7%	9%	8%	9%
20%	-3%	0%	2%	0%	0%	3%	6%	5%	5%	7%	6%
30%	-1%	-3%	0%	-1%	1%	1%	5%	5%	5%	6%	8%
40%	-4%	-4%	-1%	-1%	0%	3%	2%	3%	3%	4%	6%
50%	-6%	-3%	-2%	-1%	-2%	0%	2%	1%	3%	5%	4%
60%	-4%	-4%	-2%	-1%	-1%	0%	0%	1%	1%	2%	2%
70%	-5%	-5%	-3%	-4%	-1%	-2%	-1%	0%	1%	1%	3%
80%	-8%	-6%	-5%	-4%	-2%	-1%	-1%	-1%	1%	2%	2%
90%	-7%	-6%	-5%	-3%	-4%	-3%	-2%	-1%	0%	0%	1%
100%	-7%	-7%	-5%	-4%	-4%	-3%	-3%	-1%	-1%	0%	0%

Table 94: Change in standard deviation of Type IV Bank EBIT assuming 25 basis points expected rise in rates every year

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated trough investment management, underwriting services, and trading. We simulate EBIT of our hypothetical bank under scenario of 25 basis points rise in rates every year during the five year time period. This table presents percentage changes in standard deviation of EBIT from change in rates. Our benchmark is standard deviation of EBIT in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	5%	7%	8%	3%	2%	-4%	0%	13%	4%	7%	12%
10%	10%	2%	15%	6%	3%	0%	1%	8%	12%	22%	14%
20%	-1%	5%	-3%	-2%	-8%	4%	11%	7%	15%	5%	11%
30%	3%	0%	7%	0%	-9%	1%	-2%	8%	18%	10%	22%
40%	0%	-4%	1%	-4%	-1%	6%	-2%	7%	11%	14%	6%
50%	-10%	0%	4%	-1%	2%	5%	8%	9%	7%	12%	15%
60%	11%	-2%	-1%	11%	0%	2%	-2%	5%	1%	7%	6%
70%	-6%	2%	-1%	3%	2%	6%	8%	8%	12%	6%	1%
80%	3%	-3%	5%	-1%	-2%	-2%	-10%	7%	3%	6%	11%
90%	4%	3%	2%	5%	3%	4%	2%	3%	-4%	-4%	5%
100%	5%	9%	-1%	3%	0%	2%	-1%	0%	10%	1%	6%

Table 95: Change in Type IV Bank EBIT assuming 75 basis points expected rise in rates every year

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated trough investment management, underwriting services, and trading. We simulate EBIT of our hypothetical bank under scenario of 75 basis points rise in rates every year during the five year time period. This table presents percentage changes in EBIT from change in rates. Our benchmark is EBIT in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	1%	5%	12%	12%	17%	21%	22%	28%	30%	32%	34%
10%	-2%	-1%	6%	9%	12%	17%	19%	21%	26%	26%	29%
20%	-7%	-3%	1%	4%	6%	11%	15%	17%	17%	22%	24%
30%	-8%	-6%	-2%	0%	5%	6%	12%	13%	15%	19%	23%
40%	-11%	-8%	-6%	-3%	1%	6%	7%	9%	11%	15%	17%
50%	-14%	-9%	-7%	-4%	-2%	0%	4%	5%	9%	11%	13%
60%	-14%	-12%	-9%	-7%	-4%	-2%	1%	3%	5%	8%	10%
70%	-17%	-13%	-11%	-9%	-6%	-4%	-1%	1%	4%	6%	7%
80%	-20%	-16%	-14%	-11%	-8%	-6%	-4%	-1%	2%	4%	5%
90%	-21%	-18%	-15%	-12%	-10%	-8%	-5%	-3%	-1%	1%	3%
100%	-22%	-19%	-16%	-15%	-12%	-10%	-9%	-7%	-3%	-1%	0%

Table 96: Change in standard deviation of Type IV Bank EBIT assuming 75 basis points expected rise in rates every year

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated trough investment management, underwriting services, and trading. We simulate EBIT of our hypothetical bank under scenario of 75 basis points rise in rates every year during the five year time period. This table presents percentage changes in standard deviation of EBIT from change in rates. Our benchmark is standard deviation of EBIT in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	-4%	6%	20%	15%	15%	28%	22%	55%	53%	59%	81%
10%	5%	-3%	12%	11%	21%	23%	30%	37%	57%	70%	60%
20%	-7%	2%	-3%	7%	6%	18%	23%	39%	41%	48%	51%
30%	2%	7%	5%	8%	8%	16%	21%	27%	35%	32%	49%
40%	-6%	2%	5%	-3%	3%	15%	23%	38%	23%	42%	48%
50%	3%	2%	0%	-7%	4%	6%	15%	22%	31%	32%	45%
60%	9%	-2%	0%	7%	-2%	10%	4%	10%	20%	22%	28%
70%	3%	3%	5%	11%	-1%	7%	3%	13%	15%	16%	27%
80%	12%	-2%	7%	3%	3%	4%	3%	16%	13%	25%	20%
90%	15%	12%	12%	-1%	-5%	3%	5%	3%	0%	6%	13%
100%	30%	16%	12%	6%	4%	2%	-10%	6%	15%	12%	14%

Table 97: Change in Type IV Bank EBIT assuming 75 basis points expected drop in rates every year

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated trough investment management, underwriting services, and trading. We simulate EBIT of our hypothetical bank under scenario of 75 basis points drop in rates every year during the five year time period. This table presents percentage changes in EBIT from change in rates. Our benchmark is EBIT in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	-4%	-6%	-10%	-14%	-17%	-22%	-25%	-28%	-33%	-34%	-36%
10%	0%	-2%	-5%	-9%	-13%	-15%	-19%	-23%	-24%	-28%	-31%
20%	5%	2%	0%	-5%	-9%	-12%	-13%	-17%	-22%	-23%	-28%
30%	10%	5%	1%	-2%	-4%	-10%	-9%	-14%	-18%	-19%	-20%
40%	12%	7%	5%	1%	-2%	-3%	-8%	-11%	-13%	-15%	-17%
50%	13%	10%	8%	4%	2%	-1%	-3%	-8%	-10%	-12%	-15%
60%	15%	13%	11%	7%	5%	0%	-1%	-4%	-6%	-10%	-11%
70%	19%	14%	13%	8%	8%	3%	1%	-1%	-3%	-7%	-8%
80%	18%	17%	12%	12%	9%	6%	4%	1%	-2%	-3%	-5%
90%	20%	17%	16%	13%	9%	8%	6%	4%	2%	-1%	-3%
100%	22%	20%	17%	15%	11%	9%	7%	9%	3%	1%	-2%

Table 98: Change in standard deviation of Type IV Bank EBIT assuming 75 basis points expected drop in rates every year

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated trough investment management, underwriting services, and trading. We simulate EBIT of our hypothetical bank under scenario of 75 basis points drop in rates every year during the five year time period. This table presents percentage changes in standard deviation of EBIT from change in rates. Our benchmark is standard deviation of EBIT in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	6%	9%	12%	13%	9%	10%	8%	25%	18%	28%	22%
10%	4%	5%	14%	17%	17%	5%	7%	3%	21%	23%	18%
20%	6%	2%	0%	8%	-3%	4%	3%	14%	1%	15%	14%
30%	3%	3%	3%	6%	6%	5%	-3%	1%	14%	3%	8%
40%	-1%	-4%	9%	-4%	2%	8%	4%	3%	-1%	1%	3%
50%	2%	3%	0%	-3%	-3%	0%	4%	1%	-1%	-4%	3%
60%	24%	1%	-1%	10%	1%	1%	-6%	0%	-4%	-9%	-1%
70%	9%	2%	3%	7%	-1%	10%	-2%	-5%	-9%	-7%	-6%
80%	17%	5%	13%	4%	11%	2%	-4%	4%	-9%	-2%	-13%
90%	22%	17%	11%	15%	5%	3%	-1%	0%	-8%	-7%	-10%
100%	23%	21%	13%	11%	13%	18%	5%	7%	1%	-9%	-9%

Table 99: Change in Type IV Bank hedged EBIT assuming 75 basis points expected rise in rates every year

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated trough investment management, underwriting services, and trading. We simulate hedged EBIT of our hypothetical bank under scenario of 75 basis points rise in rates every year during the five year time period. This table presents percentage changes in hedged EBIT from change in rates. Our benchmark is EBIT in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	-1%	1%	-1%	0%	2%	-1%	0%	0%	-1%	1%	-1%
10%	-1%	2%	0%	0%	-1%	-1%	1%	1%	0%	-1%	1%
20%	2%	0%	1%	0%	1%	-1%	0%	1%	2%	1%	-1%
30%	1%	0%	1%	3%	0%	1%	0%	1%	0%	1%	-1%
40%	0%	1%	0%	2%	0%	0%	0%	0%	0%	1%	0%
50%	0%	-2%	0%	-1%	0%	0%	0%	0%	1%	0%	-1%
60%	-1%	-1%	0%	-1%	1%	0%	1%	0%	0%	0%	0%
70%	0%	-1%	1%	0%	0%	-1%	0%	0%	-1%	-1%	0%
80%	-1%	1%	0%	1%	0%	-1%	1%	-1%	-1%	0%	1%
90%	0%	0%	0%	0%	0%	0%	-1%	-1%	0%	0%	0%
100%	0%	-1%	0%	1%	0%	0%	0%	0%	0%	0%	0%

Table 100: Change in standard deviation of Type IV Bank hedged EBIT assuming 75 basis points expected rise in rates every year

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated trough investment management, underwriting services, and trading. We simulate hedged EBIT of our hypothetical bank under scenario of 75 basis points rise in rates every year during the five year time period. This table presents percentage changes in standard deviation of hedged EBIT from change in rates. Our benchmark is standard deviation of EBIT in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	2%	10%	10%	9%	-2%	3%	-8%	8%	1%	4%	-3%
10%	-1%	4%	3%	4%	3%	-4%	-5%	3%	2%	13%	6%
20%	4%	-1%	-3%	3%	2%	-1%	0%	3%	8%	0%	2%
30%	6%	5%	4%	2%	9%	-5%	1%	-2%	8%	10%	15%
40%	-3%	-5%	8%	0%	0%	8%	-5%	1%	6%	3%	4%
50%	-5%	-1%	3%	1%	-3%	1%	4%	3%	-1%	-5%	6%
60%	9%	-5%	-4%	7%	0%	-2%	-1%	3%	-11%	-5%	1%
70%	-7%	-4%	-7%	11%	3%	-1%	-4%	-2%	7%	4%	-6%
80%	2%	0%	2%	3%	10%	-9%	-7%	9%	-5%	-2%	2%
90%	5%	12%	4%	9%	-7%	-4%	8%	0%	3%	-3%	1%
100%	9%	11%	-3%	-4%	4%	-1%	-1%	10%	-1%	3%	6%

Table 101: Change in Type IV Bank hedged EBIT assuming 75 basis points expected drop in rates every year

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated trough investment management, underwriting services, and trading. We simulate hedged EBIT of our hypothetical bank under scenario of 75 basis points drop in rates every year during the five year time period. This table presents percentage changes in hedged EBIT from change in rates. Our benchmark is EBIT in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	-2%	-2%	2%	-3%	-2%	1%	-2%	0%	0%	-2%	-3%
10%	0%	-5%	0%	0%	0%	0%	1%	-1%	1%	0%	-3%
20%	-3%	-2%	-2%	-2%	-3%	-1%	1%	0%	-5%	-2%	-3%
30%	1%	-2%	0%	-4%	1%	-3%	2%	-1%	-2%	0%	2%
40%	1%	-2%	-3%	-1%	-1%	3%	-1%	-1%	-3%	-1%	-1%
50%	-1%	1%	1%	0%	-1%	-1%	1%	-3%	0%	0%	-2%
60%	2%	1%	1%	0%	0%	-1%	-2%	-1%	-1%	-2%	-1%
70%	2%	2%	2%	0%	0%	-1%	0%	2%	-1%	-1%	-2%
80%	-2%	0%	-2%	1%	1%	0%	1%	-1%	1%	1%	-1%
90%	0%	-1%	1%	2%	0%	-2%	2%	0%	0%	0%	-1%
100%	-1%	0%	0%	-1%	-1%	0%	-2%	1%	0%	0%	-2%

Table 102: Change in standard deviation of Type IV Bank hedged EBIT assuming 75 basis points expected drop in rates every year

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated trough investment management, underwriting services, and trading. We simulate hedged EBIT of our hypothetical bank under scenario of 75 basis points drop in rates every year during the five year time period. This table presents percentage changes in standard deviation of hedged EBIT from change in rates. Our benchmark is standard deviation of EBIT in the scenario of no change in rates. We present 121 various balance sheet structures, where fixed assets can vary from 0 to 100% and fixed rate liabilities can also vary from 0 to 100%. We conducted F-test for the equality of two variances and found that any change in standard deviation of more than 15% is considered significantly different from the standard deviation when rates are stable.

Fixed Assets/Liabilities	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0%	-2%	10%	13%	8%	3%	-5%	-6%	9%	3%	4%	5%
10%	9%	-3%	1%	10%	6%	1%	-1%	2%	8%	8%	1%
20%	-1%	-3%	-10%	1%	-5%	1%	-1%	3%	3%	16%	-4%
30%	6%	11%	5%	-1%	6%	2%	-5%	1%	0%	4%	1%
40%	-4%	0%	-2%	5%	-3%	10%	8%	11%	1%	3%	-6%
50%	9%	-3%	0%	4%	-7%	-1%	2%	4%	-2%	8%	3%
60%	13%	-1%	4%	12%	1%	7%	0%	1%	-2%	-1%	2%
70%	-3%	-5%	-1%	13%	2%	14%	1%	-4%	5%	3%	-2%
80%	3%	0%	0%	-4%	5%	6%	-5%	-4%	1%	16%	6%
90%	7%	6%	-3%	3%	-4%	6%	0%	7%	-4%	-7%	-3%
100%	7%	12%	-1%	4%	6%	-1%	-4%	0%	11%	9%	4%

Table 103: Coefficient of variation for Type I Bank

Coefficient of variation is calculated through the ratio of average standard deviation of income over average dollar value of income across five years for Bank Type I. Coefficient of variation represents a unit of risk per unit of return and the lower value is more favorable.

COEFFICIENT OF VARIATION FOR TYPE I BANK											
Fixed Assets/Liabilities	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0%	0.07	0.07	0.08	0.08	0.09	0.10	0.10	0.10	0.11	0.11	0.11
10%	0.07	0.07	0.08	0.08	0.09	0.09	0.10	0.10	0.10	0.11	0.11
20%	0.07	0.07	0.07	0.08	0.08	0.09	0.09	0.09	0.10	0.10	0.11
30%	0.07	0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.10	0.10	0.10
40%	0.06	0.07	0.07	0.07	0.08	0.08	0.09	0.09	0.09	0.10	0.10
50%	0.06	0.07	0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.09	0.10
60%	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.10
70%	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.09
80%	0.06	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.08	0.09	0.09
90%	0.06	0.06	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.09
100%	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08

Table 104: Coefficient of variation for Type II Bank

Coefficient of variation is calculated through the ratio of average standard deviation of income over average dollar value of income across five years for Bank Type II. Coefficient of variation represents a unit of risk per unit of return and the lower value is more favorable.

COEFFICIENT OF VARIATION FOR TYPE II BANK											
Fixed Assets/Liabilities	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0%	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.08
10%	0.05	0.05	0.05	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.08
20%	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07	0.08	0.08
30%	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.08
40%	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.08
50%	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07
60%	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07	0.07
70%	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07
80%	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07
90%	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07
100%	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.07	0.07

Table 105: Coefficient of variation for Type III Bank

Coefficient of variation is calculated through the ratio of average standard deviation of income over average dollar value of income across five years for Bank Type III. Coefficient of variation represents a unit of risk per unit of return and the lower value is more favorable.

COEFFICIENT OF VARIATION FOR TYPE III BANK											
Fixed Assets/Liabilities	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0%	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07
10%	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07
20%	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07
30%	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07
40%	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.07
50%	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.07
60%	0.04	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.07
70%	0.04	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.07
80%	0.04	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06
90%	0.04	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06
100%	0.04	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06

Table 106: Coefficient of variation for Type III Bank (EBIT)

Coefficient of variation is calculated through the ratio of average standard deviation of income over average dollar value of income across five years for Bank Type III (EBIT). Coefficient of variation represents a unit of risk per unit of return and the lower value is more favorable.

COEFFICIENT OF VARIATION FOR TYPE III (EBIT) BANK											
Fixed Assets/Liabilities	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0%	0.08	0.09	0.09	0.10	0.10	0.10	0.11	0.11	0.12	0.12	0.12
10%	0.08	0.08	0.09	0.09	0.10	0.10	0.11	0.11	0.11	0.12	0.12
20%	0.08	0.08	0.09	0.09	0.09	0.10	0.10	0.10	0.11	0.11	0.12
30%	0.07	0.08	0.08	0.09	0.09	0.09	0.10	0.10	0.10	0.11	0.11
40%	0.07	0.08	0.08	0.08	0.09	0.09	0.09	0.10	0.10	0.10	0.11
50%	0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.09	0.10	0.10	0.10
60%	0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.10	0.10
70%	0.07	0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.09	0.10	0.10
80%	0.06	0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.10
90%	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09
100%	0.06	0.06	0.07	0.07	0.08	0.08	0.08	0.08	0.09	0.09	0.09

Table 107: Coefficient of variation for Type IV Bank

Coefficient of variation is calculated through the ratio of average standard deviation of income over average dollar value of income across five years for Bank Type IV. Coefficient of variation represents a unit of risk per unit of return and the lower value is more favorable.

COEFFICIENT OF VARIATION FOR TYPE IV BANK											
Fixed Assets/Liabilities	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0%	0.08	0.08	0.08	0.08	0.09	0.08	0.09	0.09	0.09	0.09	0.10
10%	0.08	0.09	0.08	0.09	0.09	0.08	0.08	0.09	0.08	0.09	0.09
20%	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.08	0.09
30%	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.09
40%	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09
50%	0.07	0.08	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09
60%	0.07	0.07	0.08	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08
70%	0.07	0.08	0.07	0.07	0.07	0.08	0.07	0.07	0.08	0.08	0.08
80%	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08
90%	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.07	0.08	0.07	0.08
100%	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.07	0.08

Table 108: Coefficient of variation for Type IV Bank (EBIT)

Coefficient of variation is calculated through the ratio of average standard deviation of income over average dollar value of income across five years for Bank Type IV (EBIT). Coefficient of variation represents a unit of risk per unit of return and the lower value is more favorable.

COEFFICIENT OF VARIATION FOR TYPE IV (EBIT) BANK											
Fixed Assets/Liabilities	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0%	0.19	0.18	0.17	0.17	0.18	0.18	0.18	0.16	0.17	0.16	0.16
10%	0.17	0.17	0.16	0.15	0.15	0.16	0.16	0.16	0.15	0.14	0.15
20%	0.16	0.16	0.16	0.15	0.16	0.15	0.15	0.14	0.15	0.14	0.15
30%	0.15	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.13	0.14	0.13
40%	0.15	0.14	0.13	0.14	0.13	0.13	0.13	0.12	0.13	0.13	0.13
50%	0.13	0.13	0.13	0.13	0.13	0.12	0.12	0.12	0.12	0.12	0.12
60%	0.12	0.13	0.12	0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.12
70%	0.12	0.12	0.12	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.12
80%	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.10	0.11	0.10	0.11
90%	0.11	0.10	0.11	0.10	0.11	0.10	0.10	0.10	0.11	0.11	0.10
100%	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.09

APPENDIX B: FIGURES

Figure 1: Flowchart of the simulation process

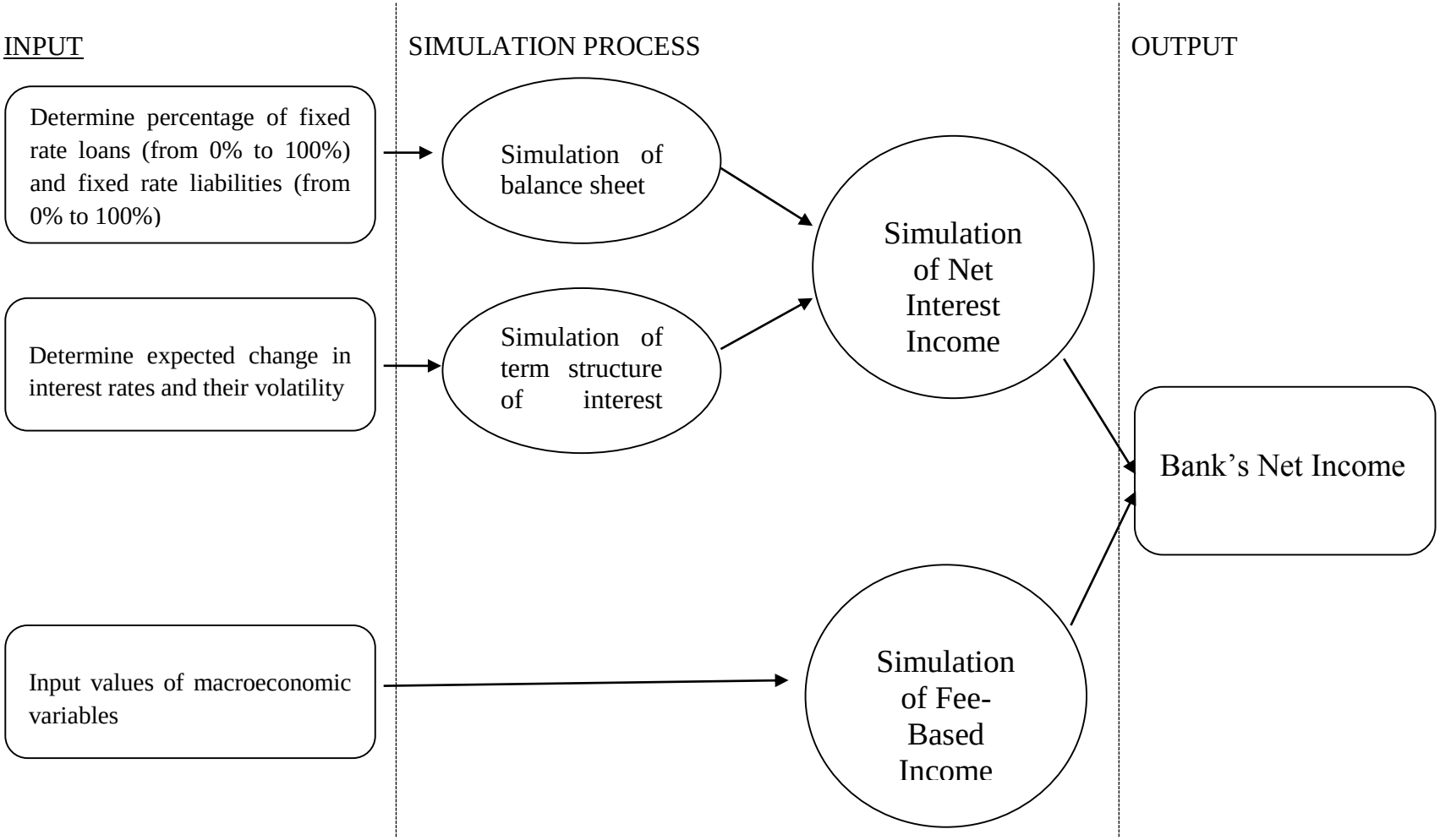


Figure 2: Net interest income and fee-based income as percentages of net revenue

This figure shows how were changing percentage contributions of net interest income and fee-based income during 1990-2011. The data is an average net interest income and fee-based income across six Canadian banks (Royal Bank of Canada, Toronto-Dominion Bank, Canadian Imperial Bank of Commerce, Bank of Montreal, Bank of Nova Scotia, and National Bank of Canada).

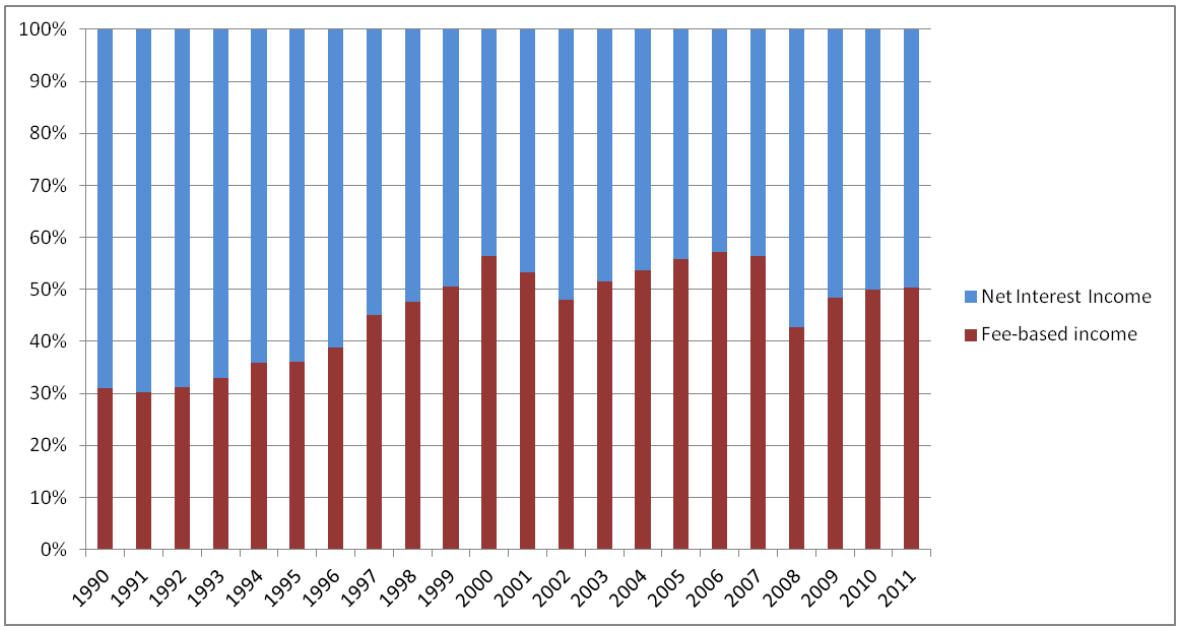


Figure 3: Traditional versus non-traditional services in a bank

These figures show composition of fee-based income for two different sub-samples of our data, before and after 2000. Traditional fee-based income consists of deposit and transaction fees, lending fees, and card fees. Non-traditional fee-based income consists of brokerage, insurance, securitization, mutual fund, trading, investment management, underwriting and advisory fees. The data is average across six Canadian banks (Royal Bank of Canada, Toronto-Dominion Bank, Canadian Imperial Bank of Commerce, Bank of Montreal, Bank of Nova Scotia, and National Bank of Canada).

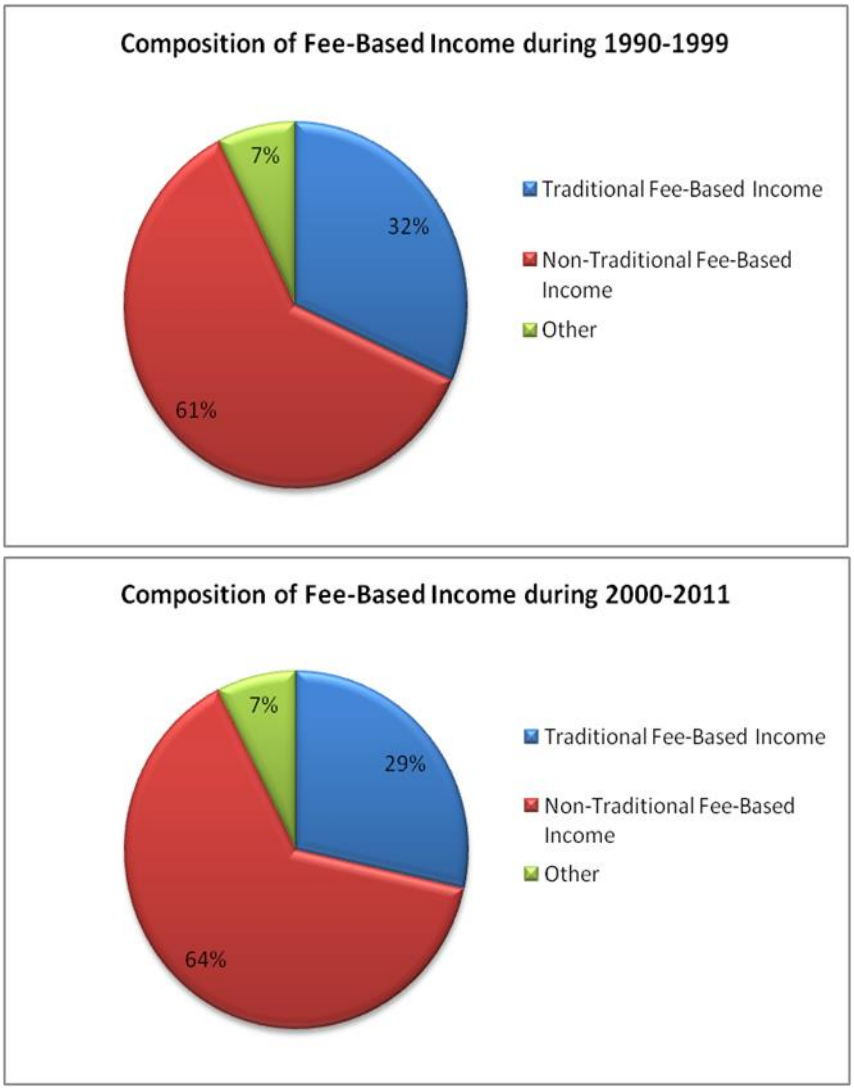
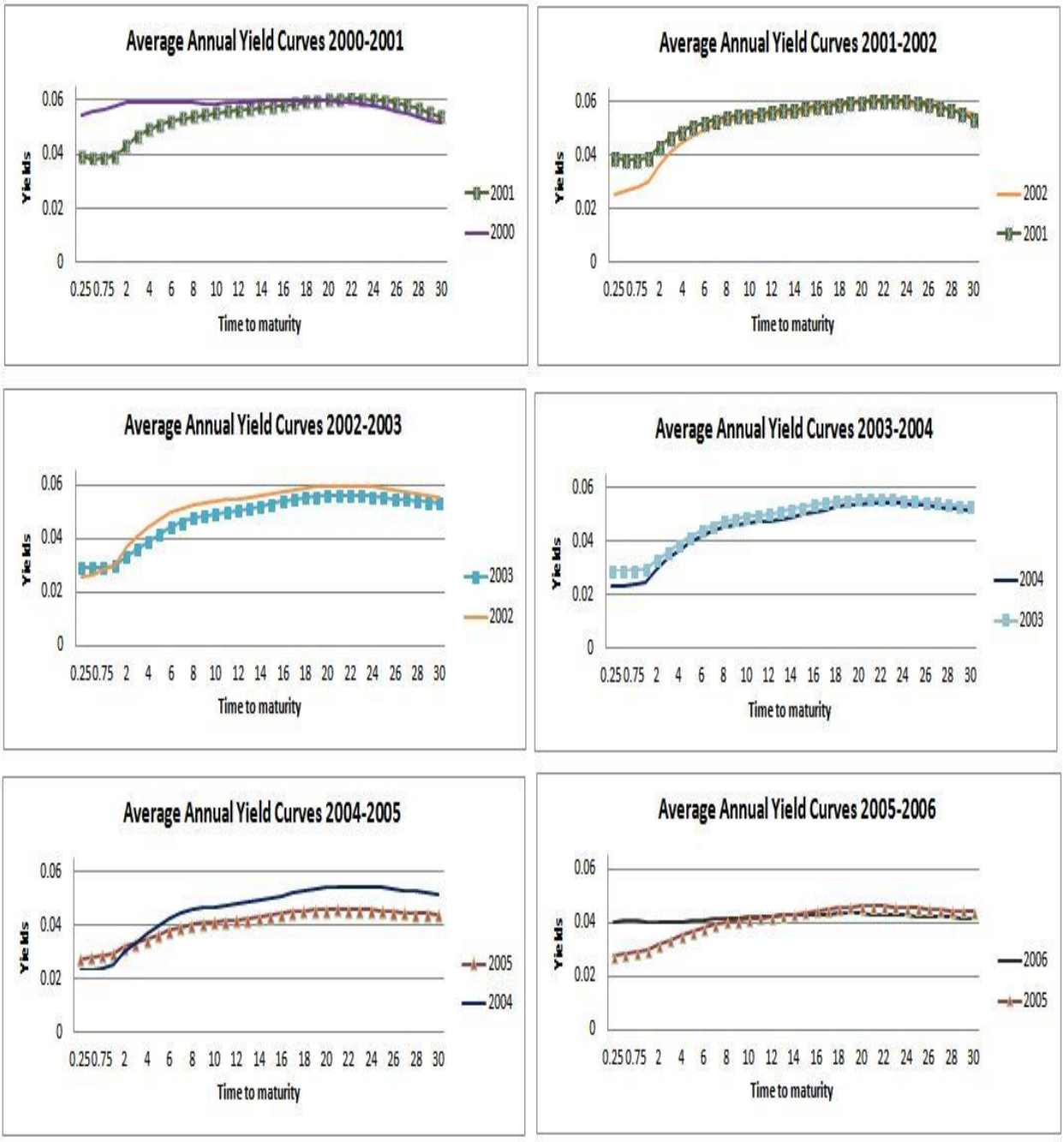
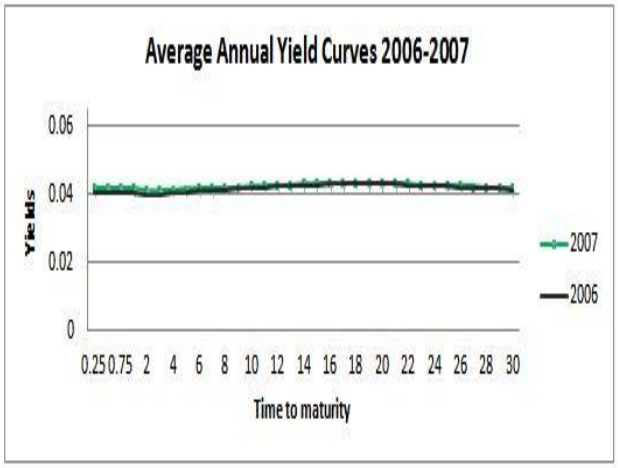
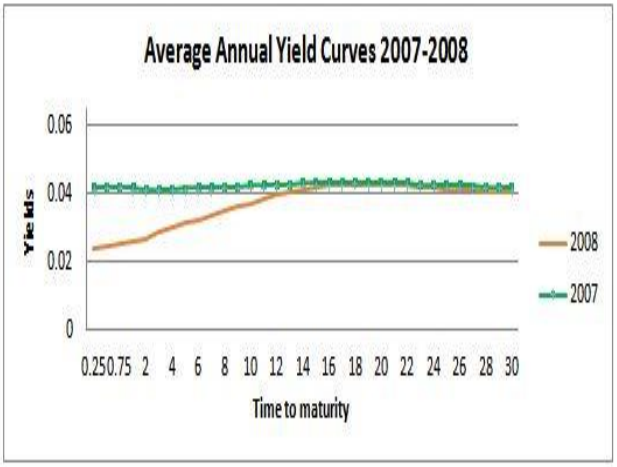


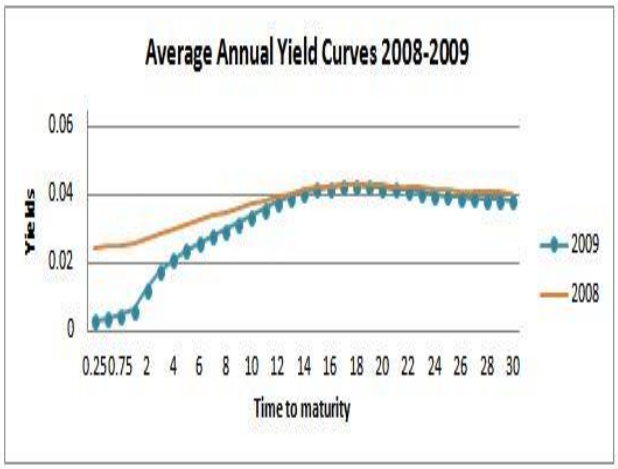
Figure 4: Annual changes in the pattern of Canadian zero-coupon yield curve

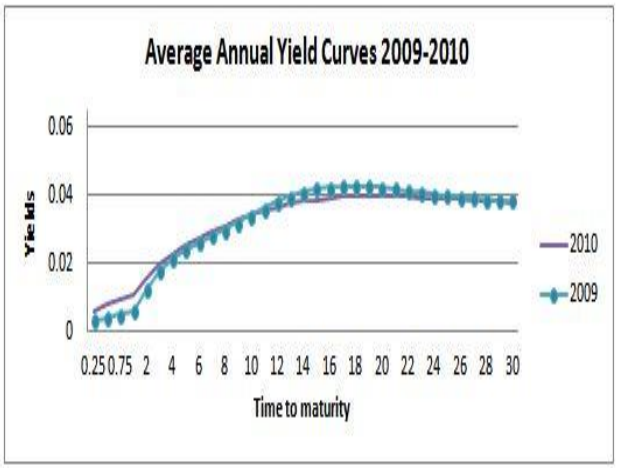
These figures show annual changes in Canadian term structure of interest rates through 2000-2012.

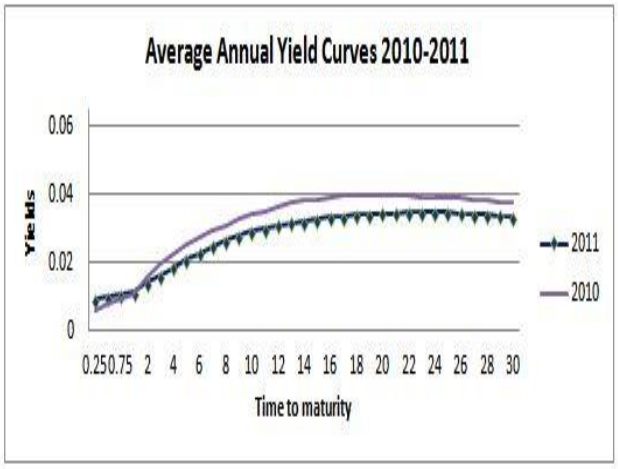



Average Annual Yield Curves 2006-2007
Yields
0.06
0.04
0.02
0
0.25 0.75 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Time to maturity
2007
2006


Average Annual Yield Curves 2007-2008
Yields
0.06
0.04
0.02
0
0.25 0.75 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Time to maturity
2008
2007


Average Annual Yield Curves 2008-2009
Yields
0.06
0.04
0.02
0
0.25 0.75 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Time to maturity
2009
2008


Average Annual Yield Curves 2009-2010
Yields
0.06
0.04
0.02
0
0.25 0.75 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Time to maturity
2010
2009


Average Annual Yield Curves 2010-2011
Yields
0.06
0.04
0.02
0
0.25 0.75 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Time to maturity
2011
2010

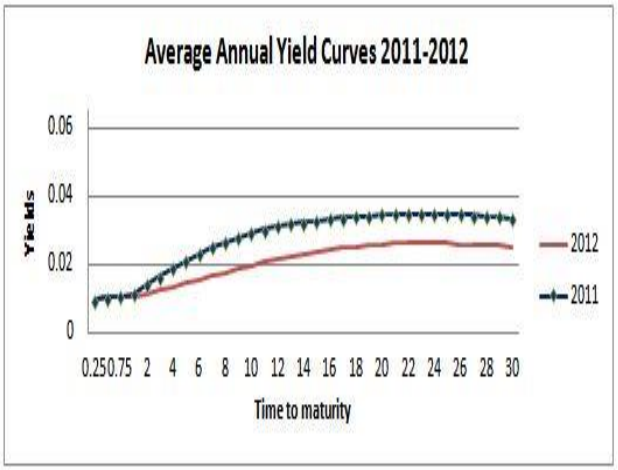

Average Annual Yield Curves 2011-2012
Yields
0.06
0.04
0.02
0
0.25 0.75 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Time to maturity
2012
2011

Figure 5: Graph of the 1-year Treasury bond yield and mortgage rates

This graph shows time series of one year Treasury bond yields and one year mortgage rate during 1990-2012. We can see that these two rates are related through almost fixed premium.

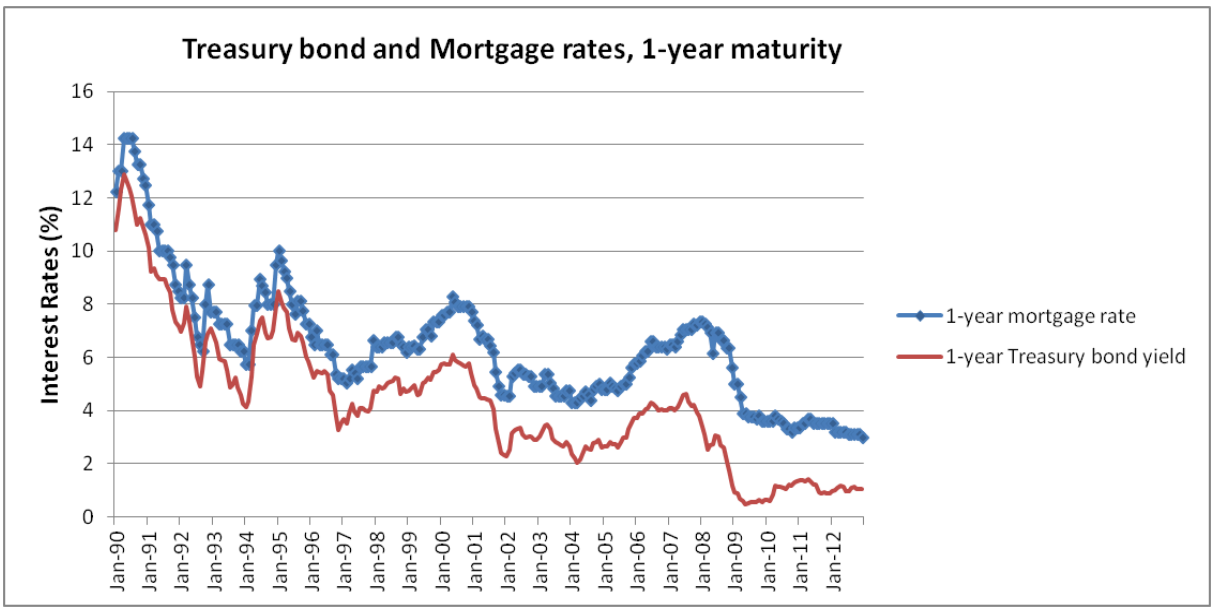


Figure 6: Graph of the 3-year Treasury bond yield and mortgage rates

This graph shows time series of three year Treasury bond yields and three year mortgage rate during 1990-2012. We can see that these two rates are related through almost fixed premium.

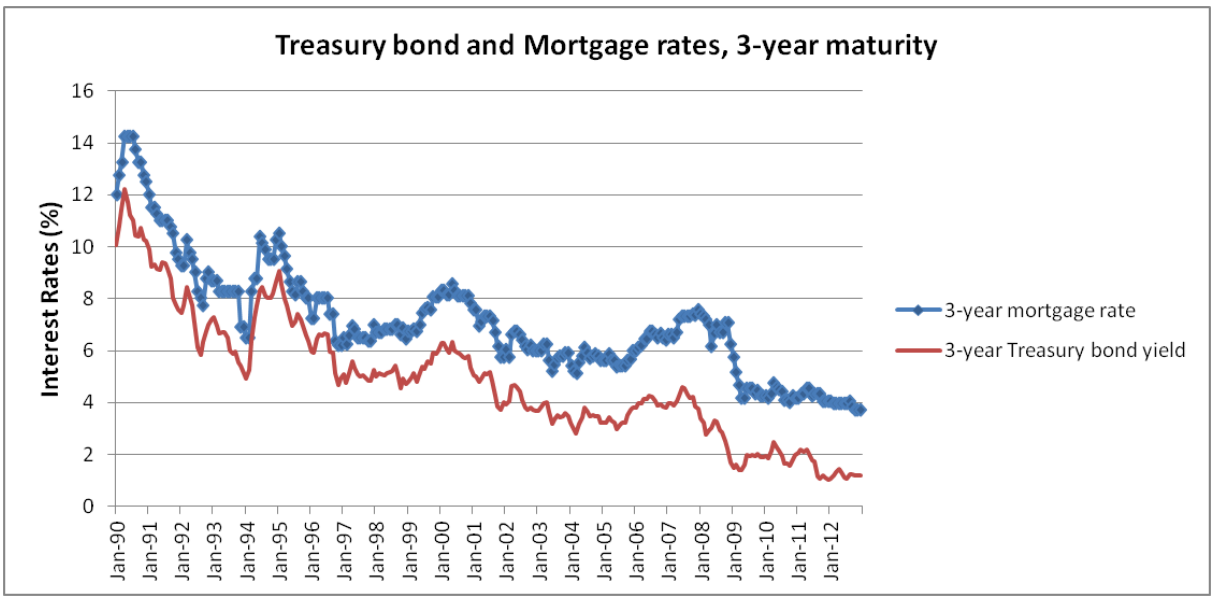


Figure 7: Graph of the 5-year Treasury bond yield and mortgage rates

This graph shows time series of five year Treasury bond yields and five year mortgage rate during 1990-2012. We can see that these two rates are related through almost fixed premium.

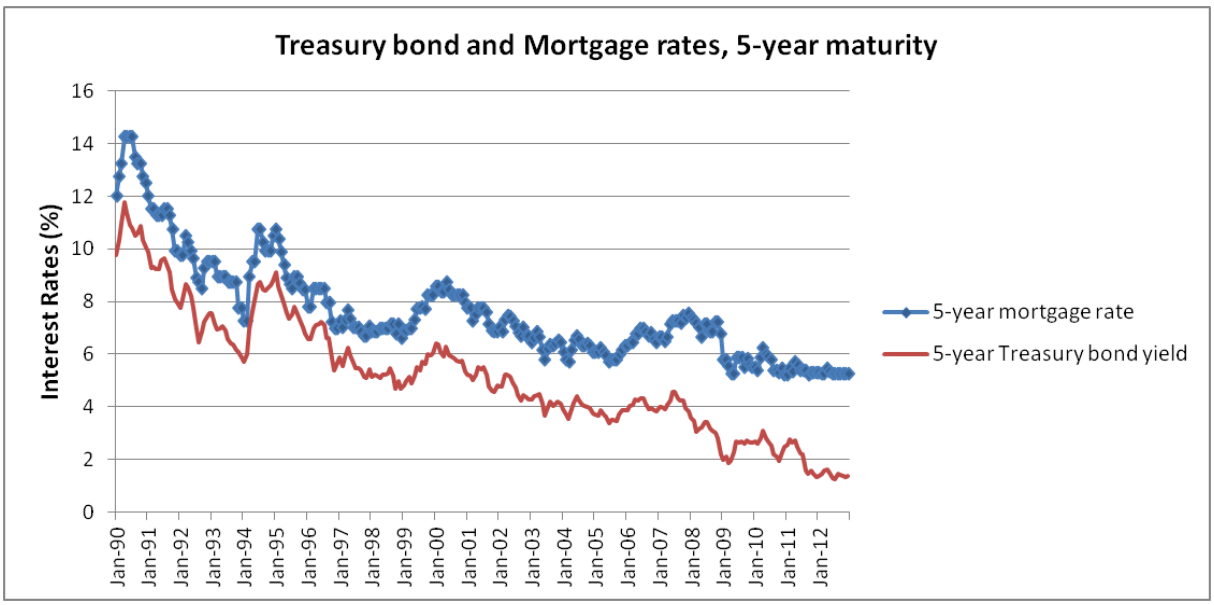
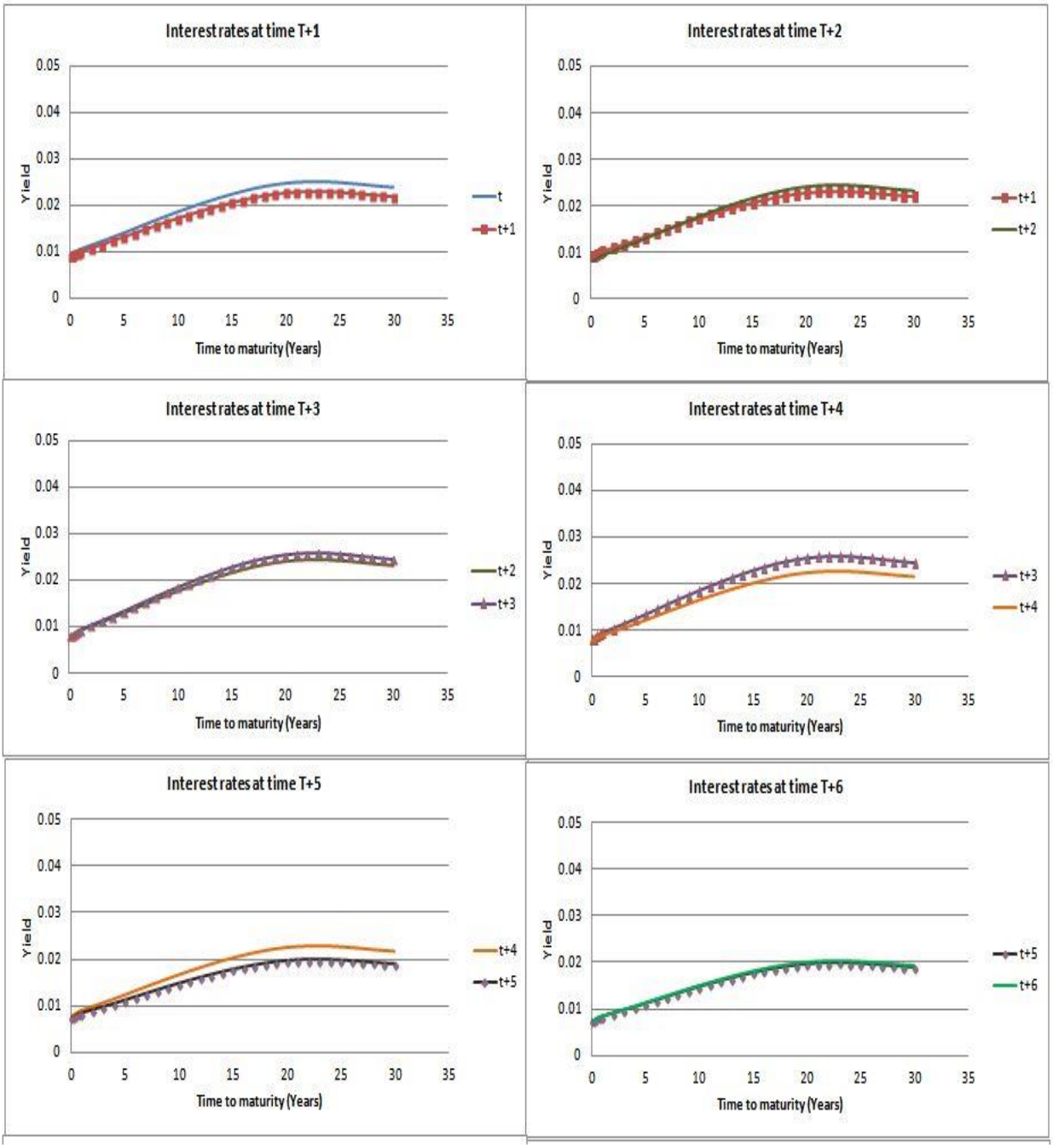


Figure 8: Simulated monthly changes in the normal yield curve

These graphs represent one iteration of our Monte-Carlo simulation of normal yield curve when there is uncertainty in the direction of future interest rates. We can see that yield curve is changing randomly from month to month. T is our starting time of simulation, and T+1 means one month after. Due to the space concerns we limit this simulation to one year (T+12).



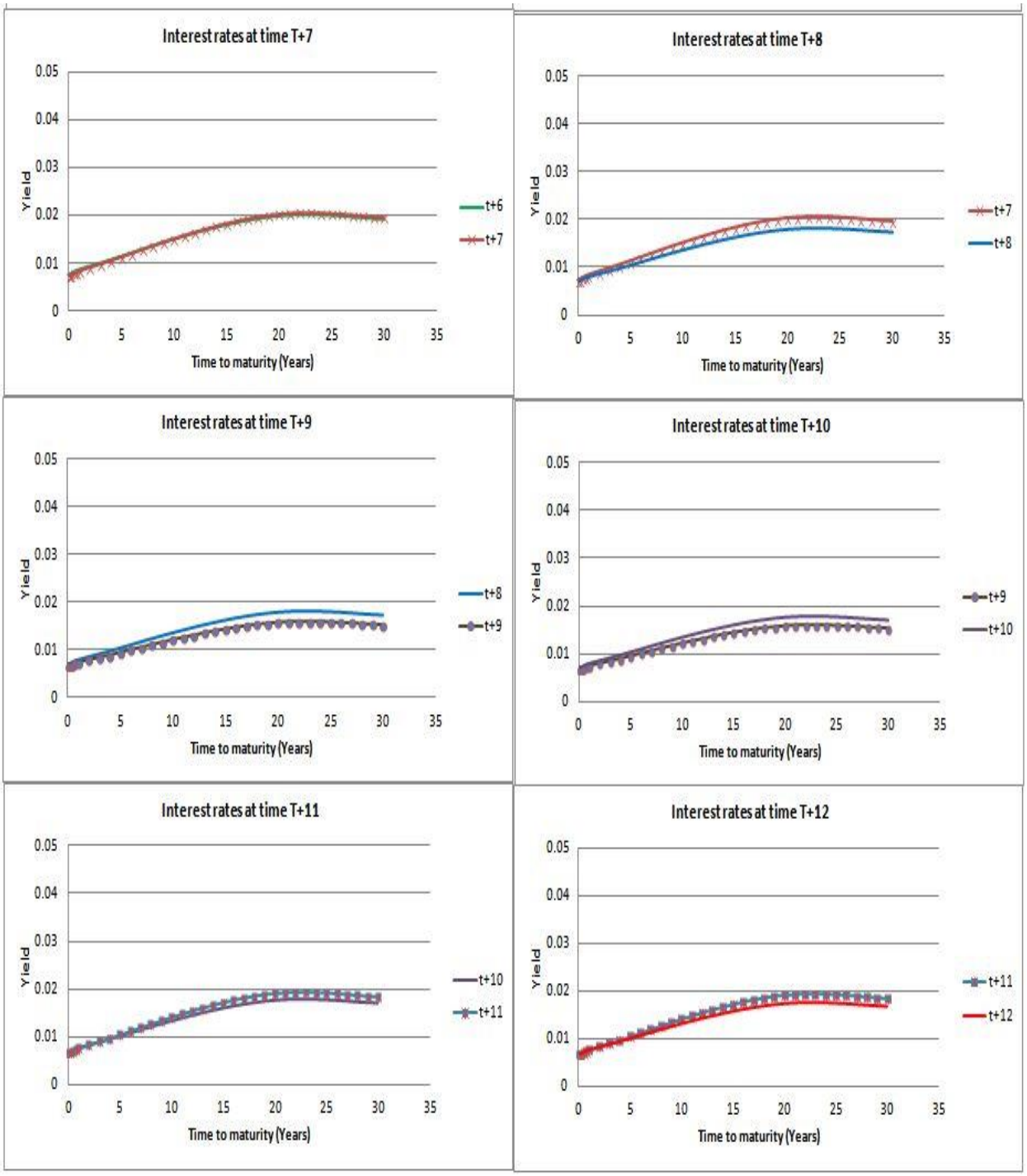

Interest rates at time T+7
Yield
Time to maturity (Years)
t+6
t+7
Interest rates at time T+8
Yield
Time to maturity (Years)
t+7
t+8
Interest rates at time T+9
Yield
Time to maturity (Years)
t+8
t+9
Interest rates at time T+10
Yield
Time to maturity (Years)
t+9
t+10
Interest rates at time T+11
Yield
Time to maturity (Years)
t+10
t+11
Interest rates at time T+12
Yield
Time to maturity (Years)
t+11
t+12

Figure 9: Simulated annual changes in the normal yield curve

These graphs represent six iterations of our Monte-Carlo simulation of normal yield curve assuming uncertainty in the direction of interest rates. We can see that the annual change in yield curve can have different forms. These graphs reflect the random nature of our spreadsheet Monte-Carlo simulation.

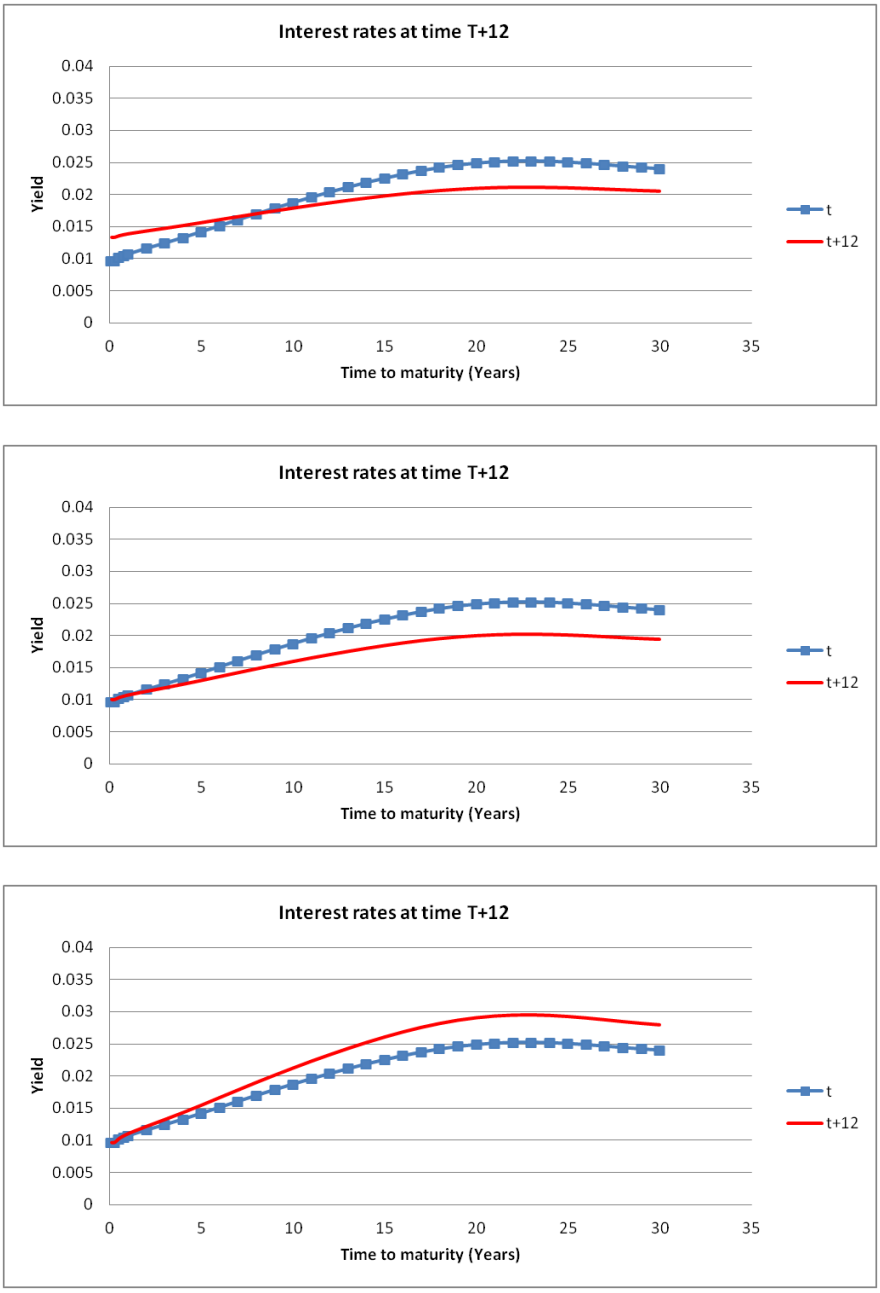
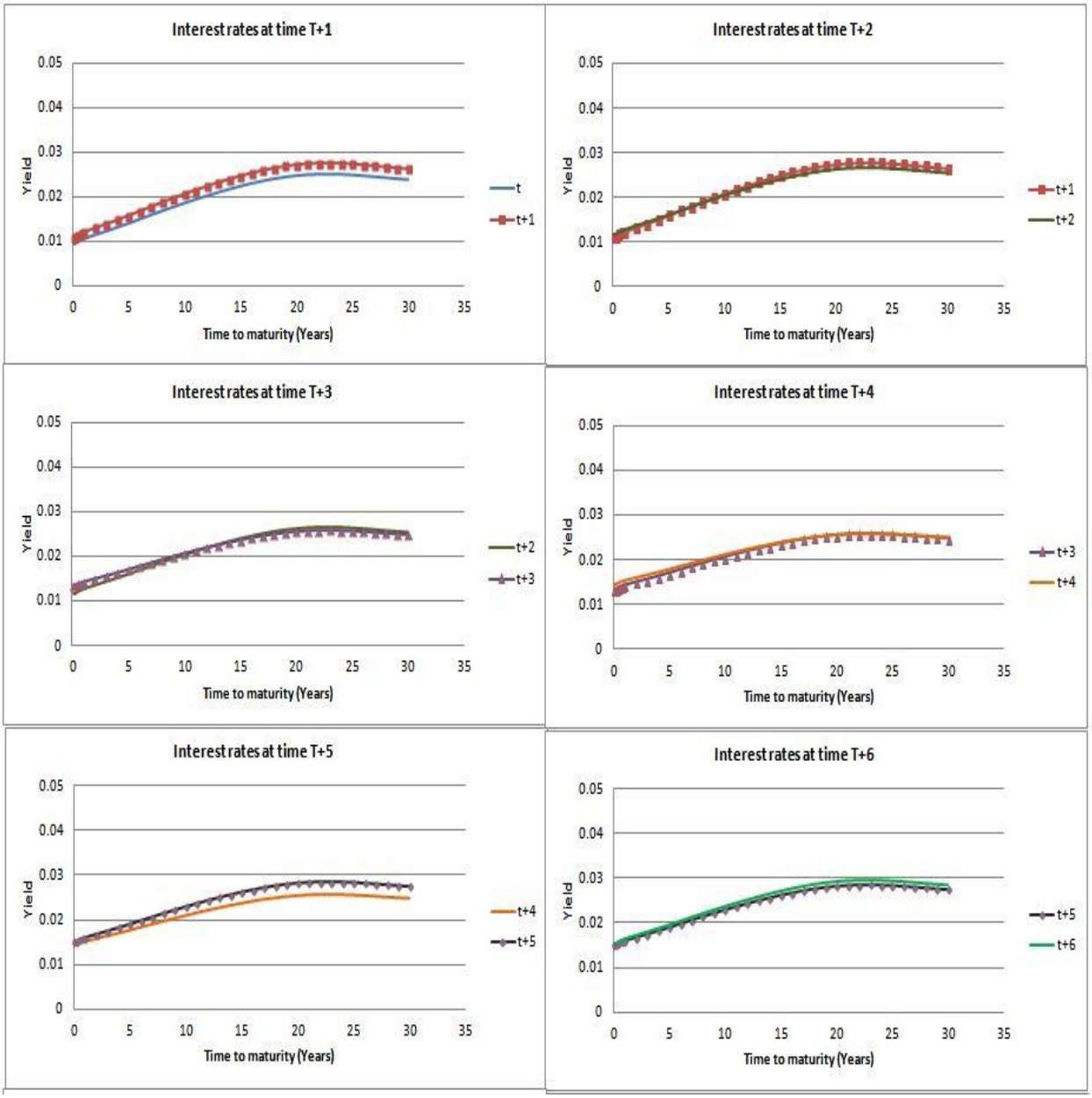


Figure 10: Scenario of rise in the interest rates. Monthly changes in the yield curve.

These graphs represent one iteration of our Monte-Carlo simulation of a scenario of normal yield curve with expected rise in rates. We can see that yield curve is changing randomly from month to month, still following the upward trend. T is our starting time of simulation, and T+1 means one month after. Due to the space concerns we limit this simulation to one year (T+12).



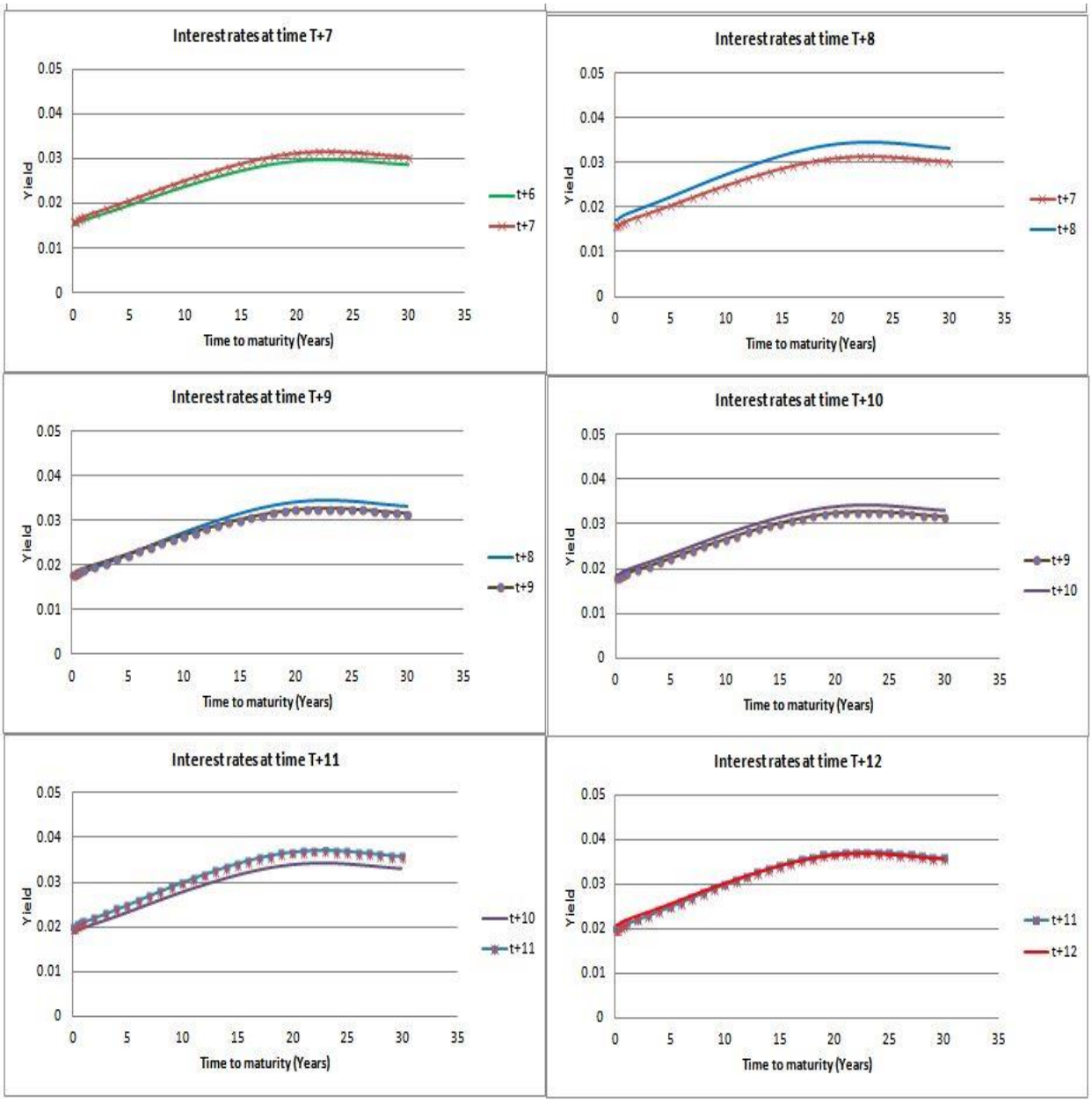

Interest rates at time T+7
Yield
Time to maturity (Years)
t+6
t+7
Interest rates at time T+8
Yield
Time to maturity (Years)
t+7
t+8
Interest rates at time T+9
Yield
Time to maturity (Years)
t+8
t+9
Interest rates at time T+10
Yield
Time to maturity (Years)
t+9
t+10
Interest rates at time T+11
Yield
Time to maturity (Years)
t+10
t+11
Interest rates at time T+12
Yield
Time to maturity (Years)
t+11
t+12

Figure 11: Scenario of rise in the interest rates. Annual changes in the yield curve.

These graphs represent three iterations of our Monte-Carlo simulation of normal yield curve when rates are expected to rise. We can see that the annual change in yield curve can have different magnitude and slope. These graphs reflect the random nature of our spreadsheet Monte-Carlo simulation.

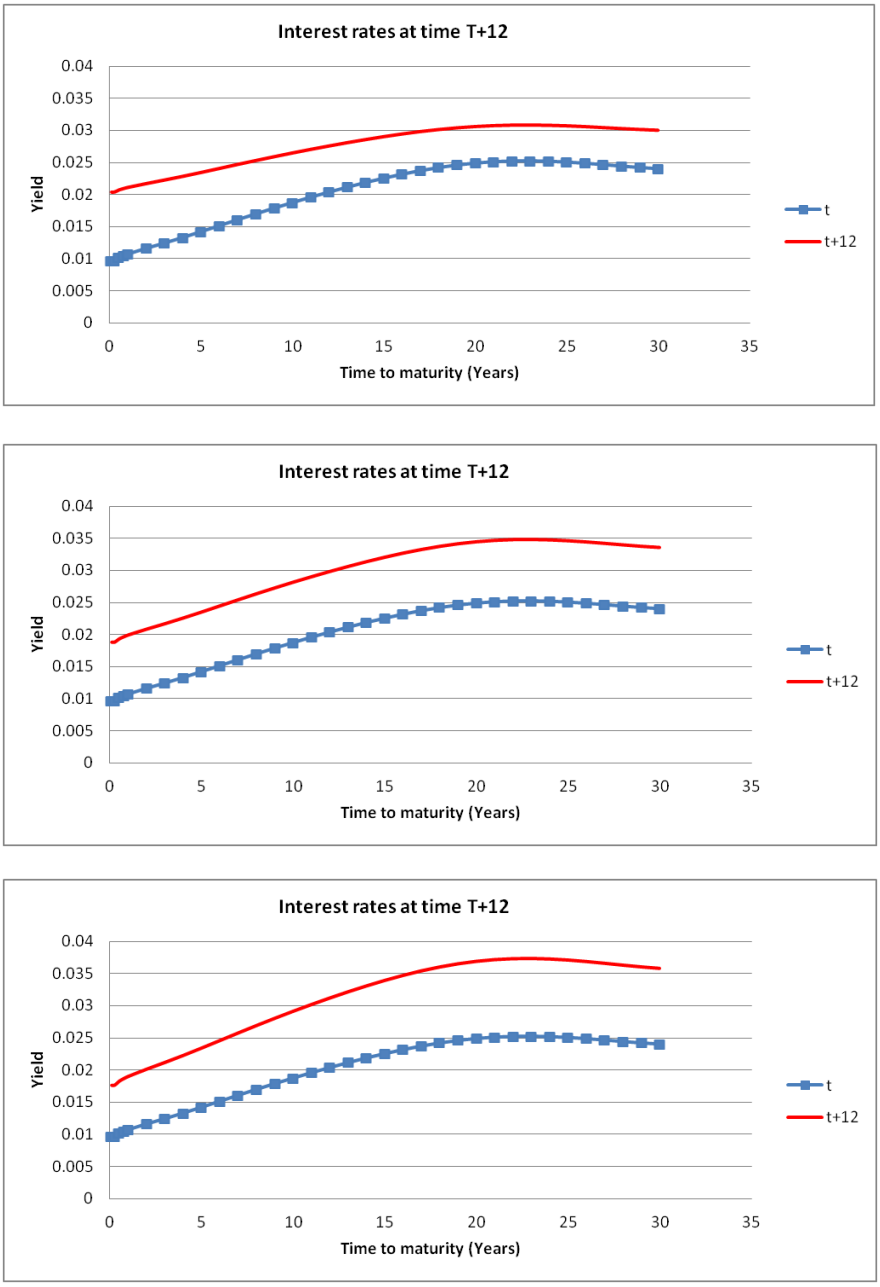
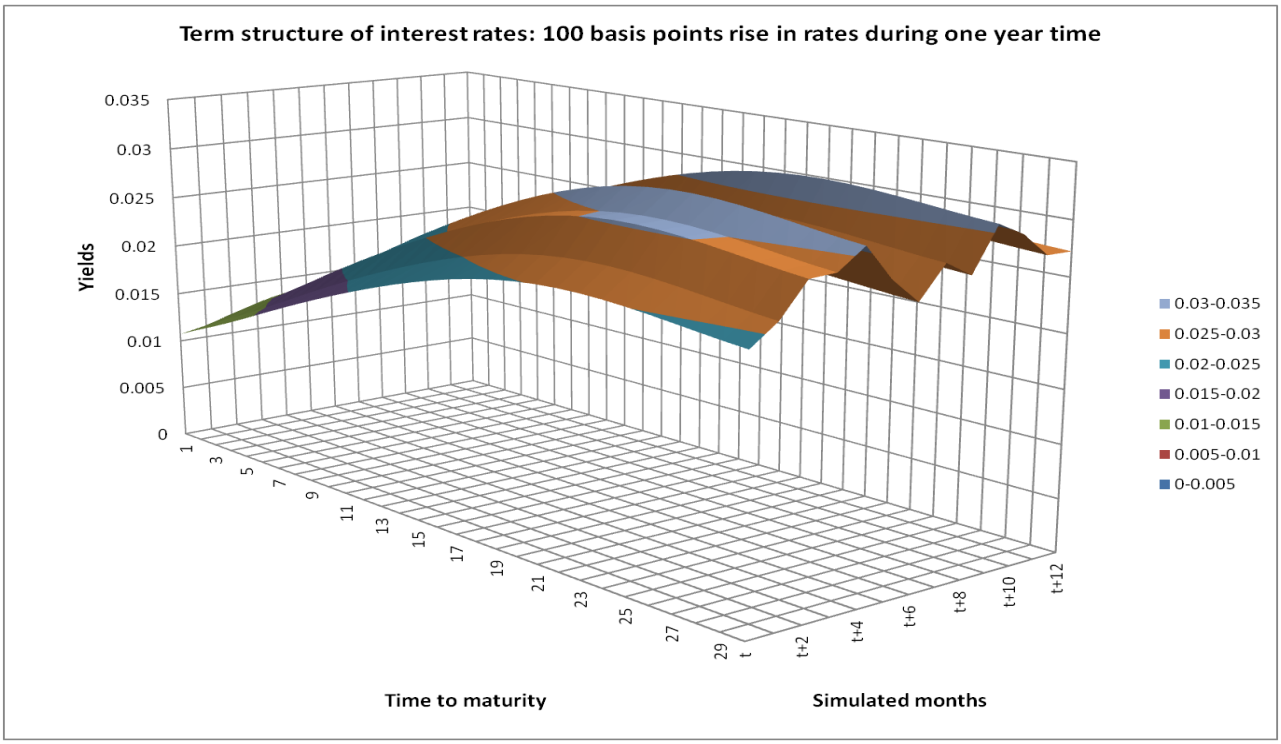


Figure 12: 3D graphs of the evolution of the term structure of interest rates assuming 100 basis points expected increase in rates over a period of one year.

These two graphs show two iterations of our Monte-Carlo simulation of the yield curve. The graphs show the random nature of monthly changes in the yield curve when interest rates are expected to raise 100 basis points over a period of one year.

Simulation 1:



Simulation 2

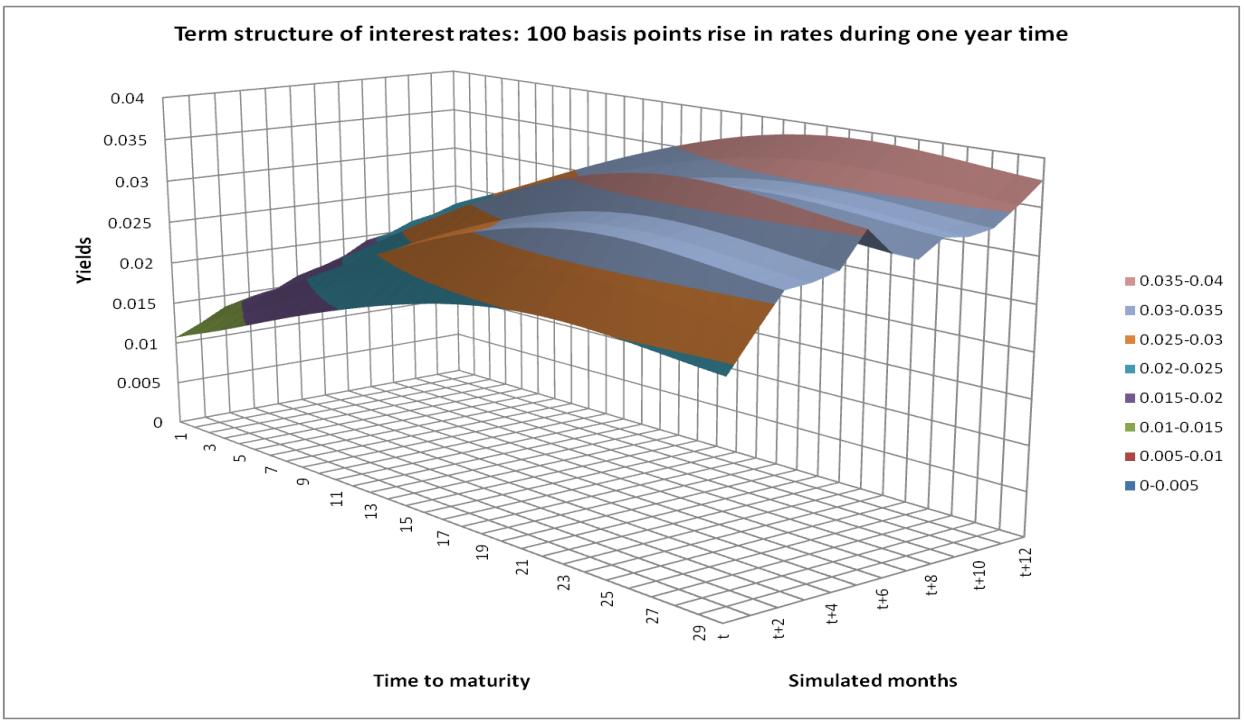
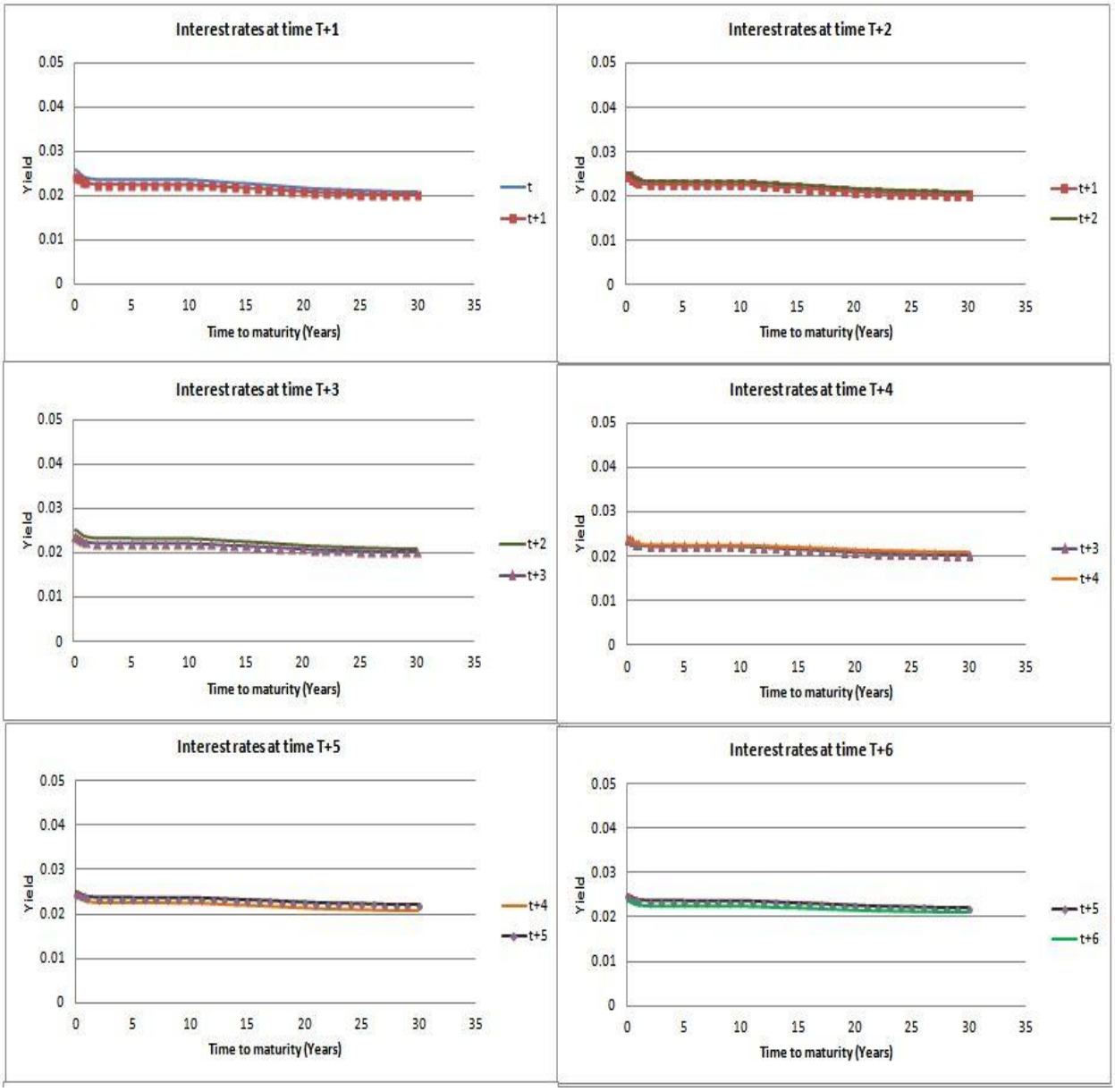


Figure 13: Scenario of inverted yield curve. Monthly changes in the yield curve.

These graphs represent one iteration of our Monte-Carlo simulation of a scenario of normal yield curve with expected drop in rates. We can see that yield curve is changing randomly from month to month, still following the downward trend. T is our starting time of simulation, and T+1 means one month after. Due to the space concerns we limit this simulation to one year (T+12) only.



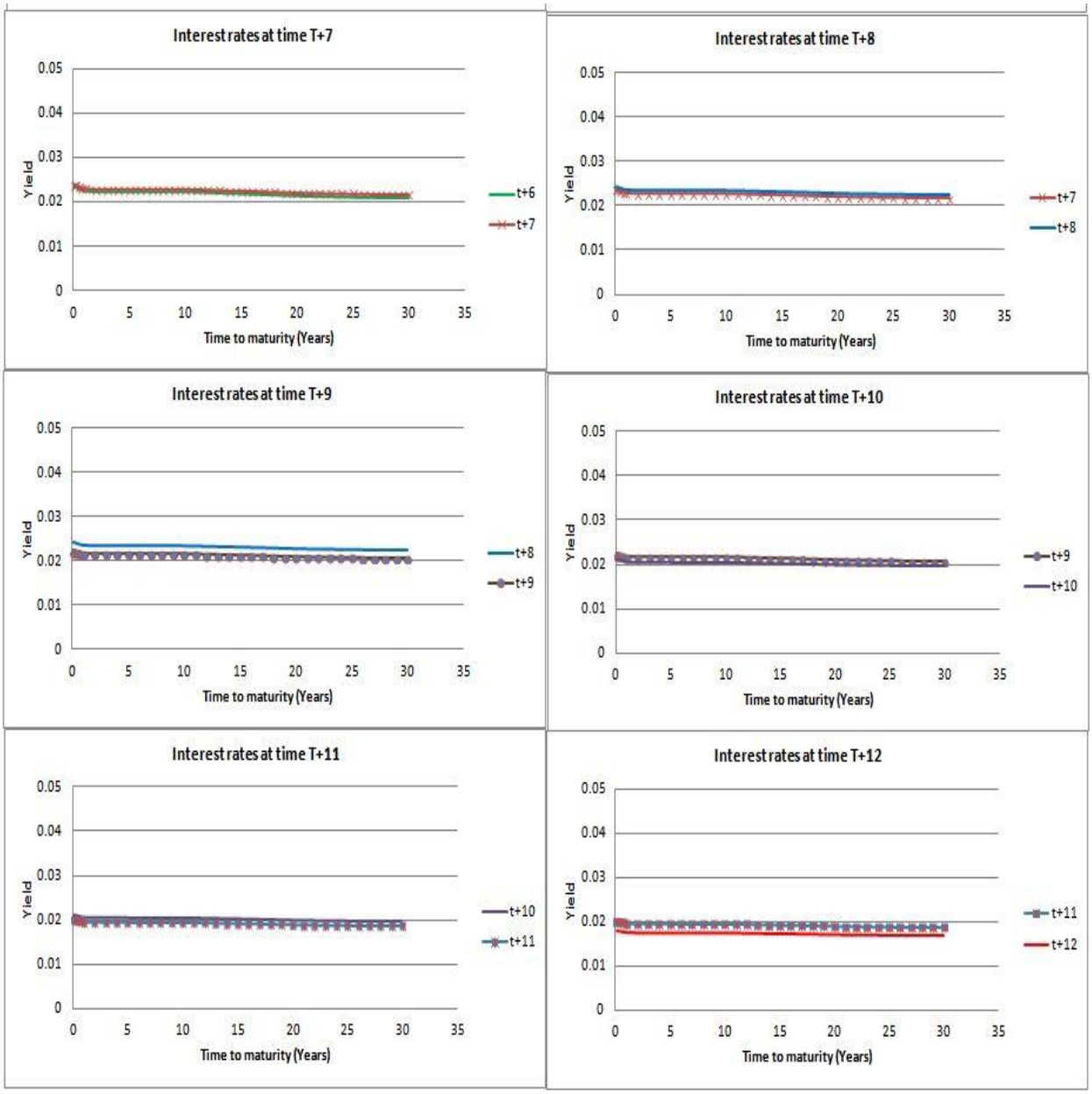

Interest rates at time T+7
Yield
Time to maturity (Years)
t+6
t+7
Interest rates at time T+8
Yield
Time to maturity (Years)
t+7
t+8
Interest rates at time T+9
Yield
Time to maturity (Years)
t+8
t+9
Interest rates at time T+10
Yield
Time to maturity (Years)
t+9
t+10
Interest rates at time T+11
Yield
Time to maturity (Years)
t+10
t+11
Interest rates at time T+12
Yield
Time to maturity (Years)
t+11
t+12

Figure 14: Scenario of inverted yield curve. Annual changes in the yield curve.

These graphs represent five iterations of our Monte-Carlo simulation of normal yield curve when rates are expected to drop. We can see that the annual change in yield curve can have different magnitude and slope. These graphs reflect the random nature of our spreadsheet Monte-Carlo simulation.

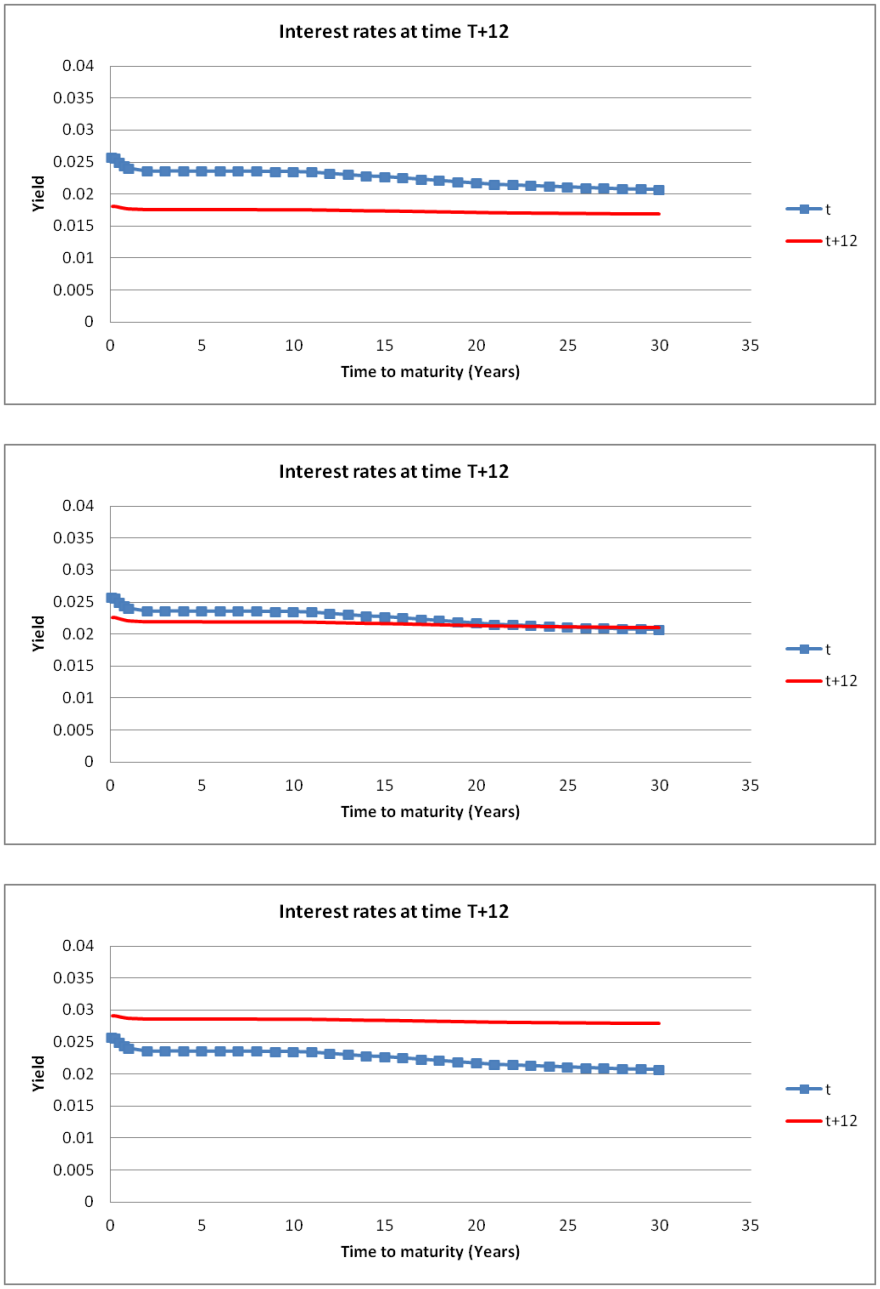
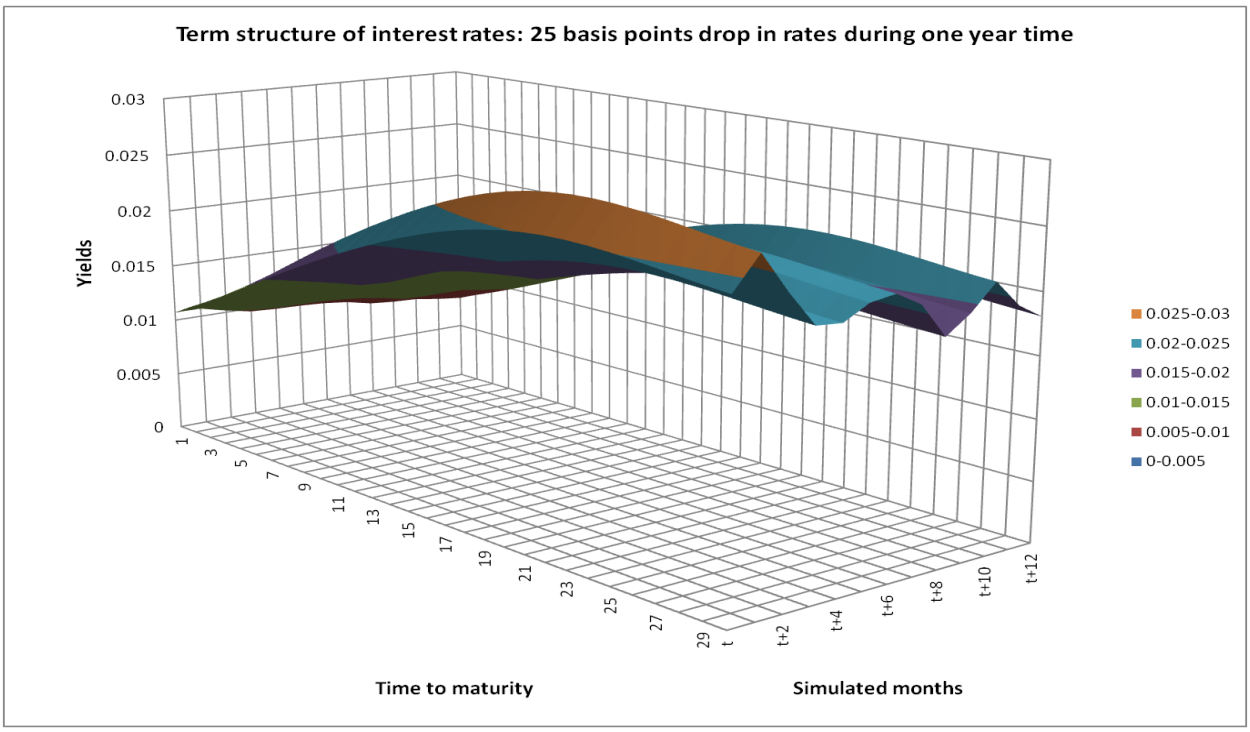


Figure 15: 3D graph of the evolution of the term structure of interest rates assuming 25 basis points expected drop in rates over a period of one year.

These two graphs show two iterations of our Monte-Carlo simulation of the yield curve. The graphs show the random nature of monthly changes in the yield curve when interest rates are expected to fall 25 basis points over a period of one year.

Simulation 1:



Simulation 2:

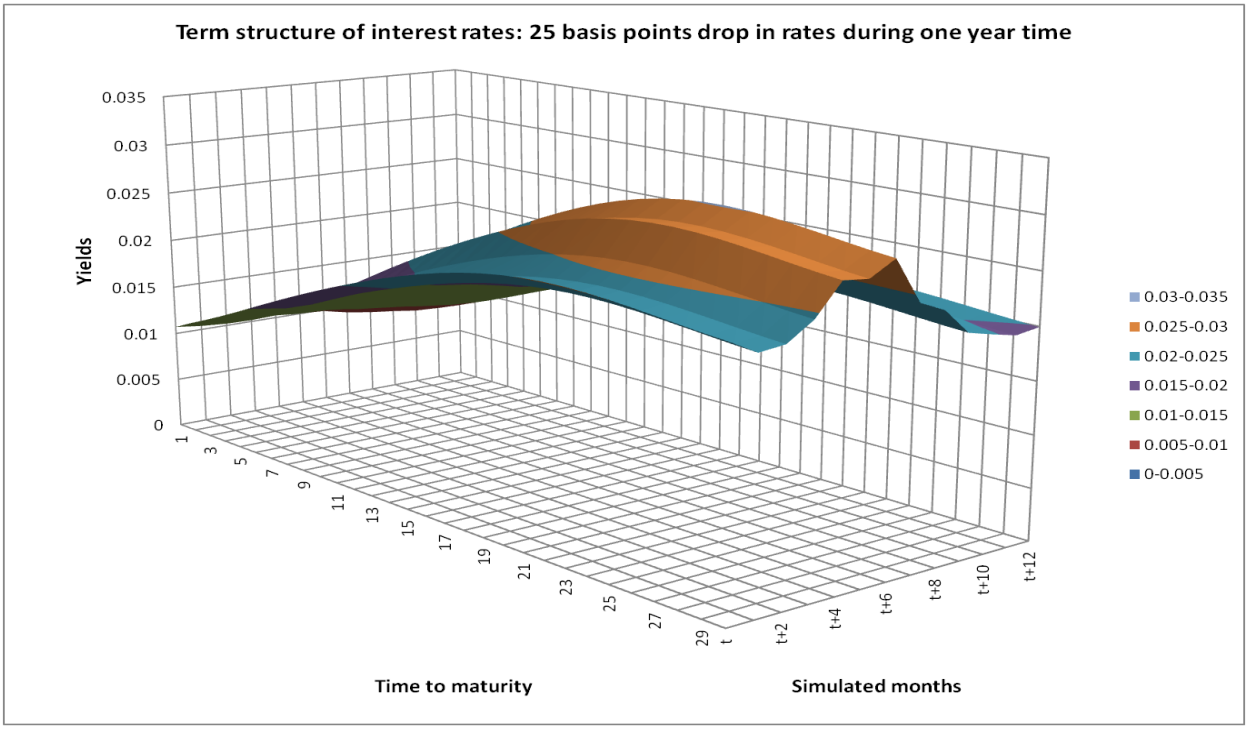


Figure 16: 3D graph of change in Type I Bank average income assuming 75 basis points expected rise in rates every year

Type I bank generates only net interest income. This figure shows a 3D graph of changes in income for Type I bank given 75 basis points rise in interest rates. The surface shows 121 scenarios of structures of balance sheet. "A" represents fixed rate assets that could vary from 0% to 100%, and "L" represents fixed rate liabilities that also could vary from 0% to 100%. Percentage change in income shows the difference in income when there was no change in rates and when rates went up.

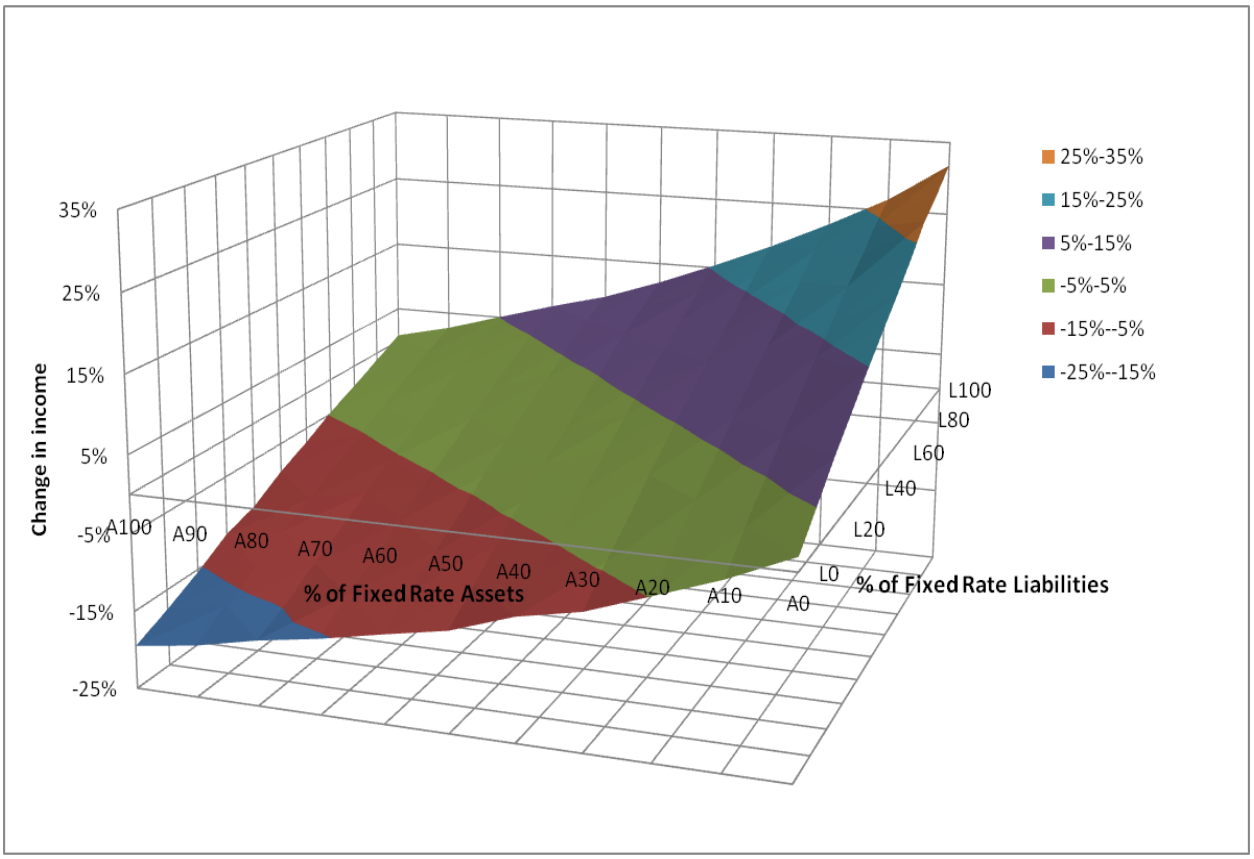
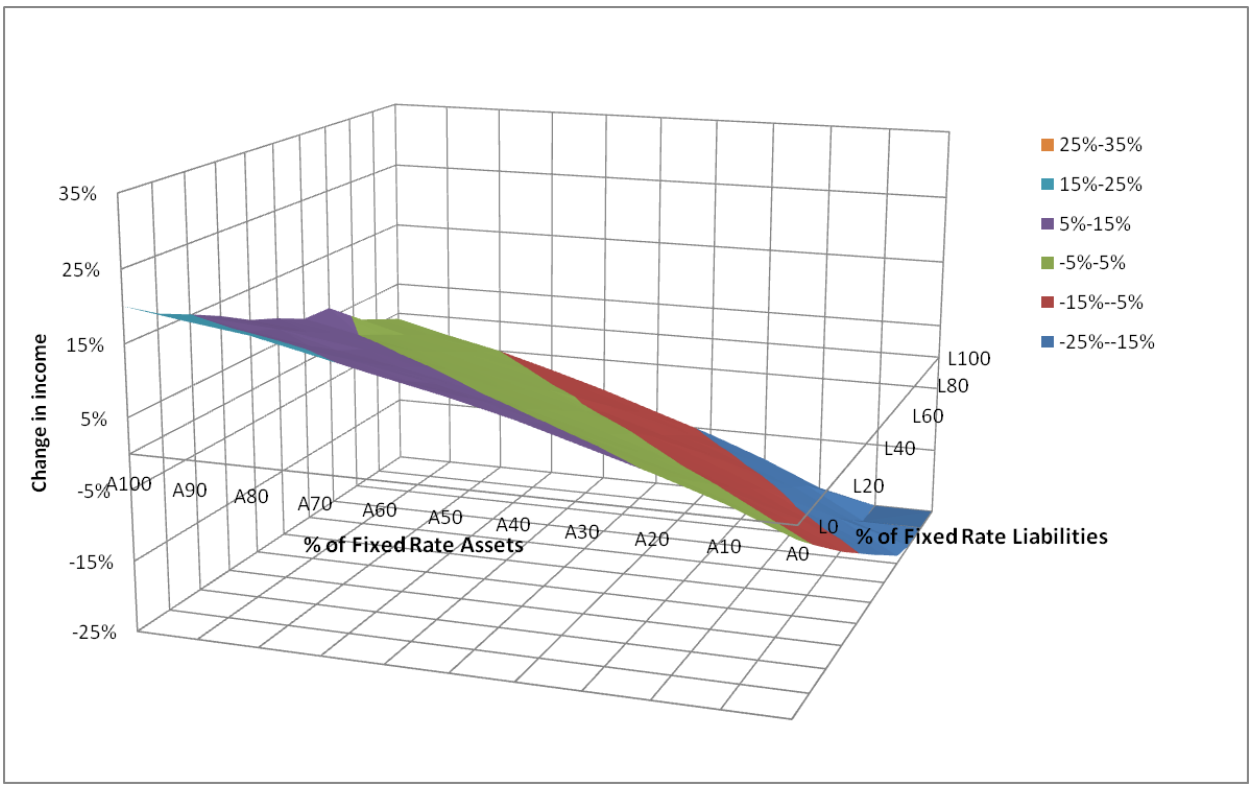


Figure 17: 3D graph of change in Type I Bank average income assuming 75 basis points expected drop in rates every year

Type I bank generates only net interest income. This figure shows a 3D graph of changes in income for Type I bank given 75 basis points drop in interest rates. The surface shows 121 scenarios of structures of balance sheet. "A" represents fixed rate assets that could vary from 0% to 100%, and "L" represents fixed rate liabilities that also could vary from 0% to 100%. Percentage change in income shows the difference in income when there was no change in rates and when rates went down.

View 1: Surface from the same angle as other 3D graphs



View 2: Rotated 3D graph that allows seeing the same surface from a different angle.

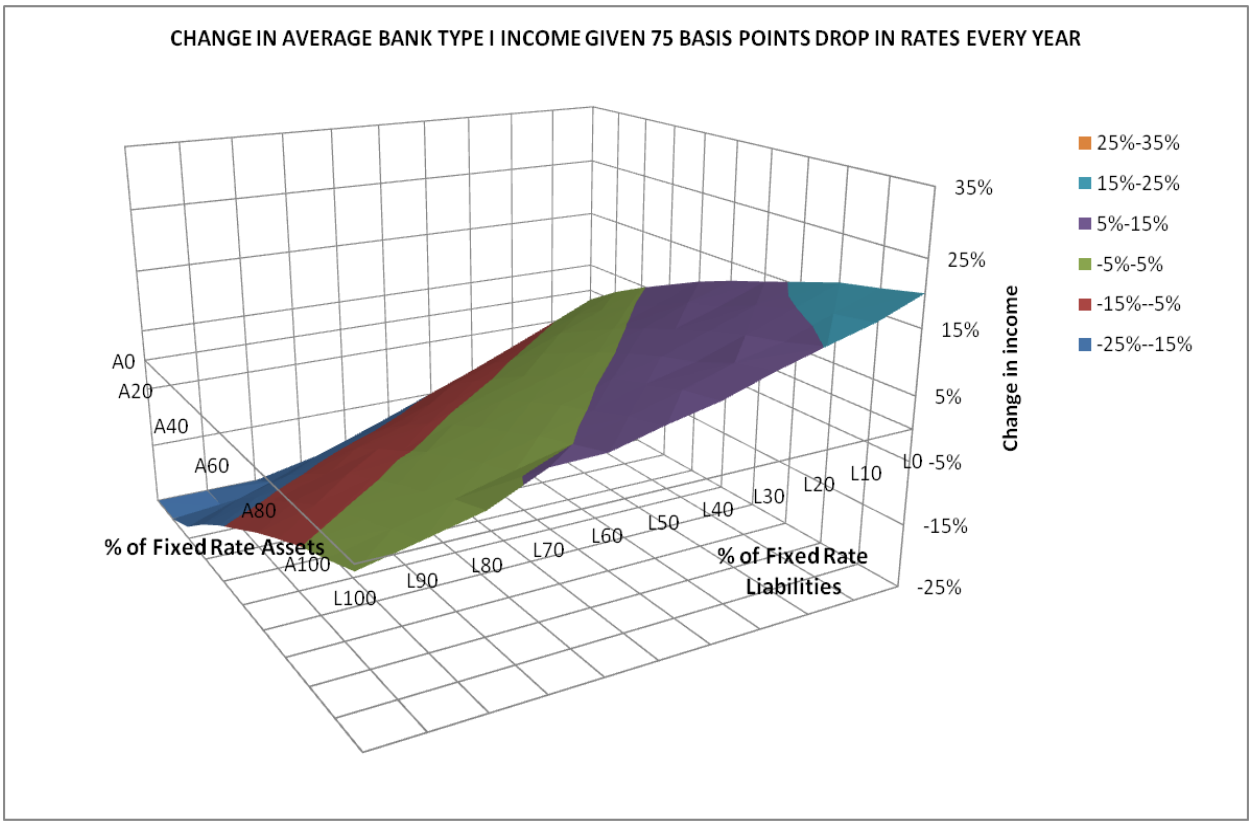


Figure 18: 3D graph of change in Type II Bank average income assuming 75 basis points expected rise in rates every year

Type II bank, in addition to net interest income, presents some fee-based income that is related to generation of loans and deposits. This fee-based income is called traditional and is generated through deposit and payment services, lending fees, and card fees. This figure shows a 3D graph of changes in income for Type II bank given 75 basis points rise in interest rates. The surface shows 121 scenarios of structures of balance sheet. "A" represents fixed rate assets that could vary from 0% to 100%, and "L" represents fixed rate liabilities that also could vary from 0% to 100%. Percentage change in income shows the difference in income when there was no change in rates and when rates went up.

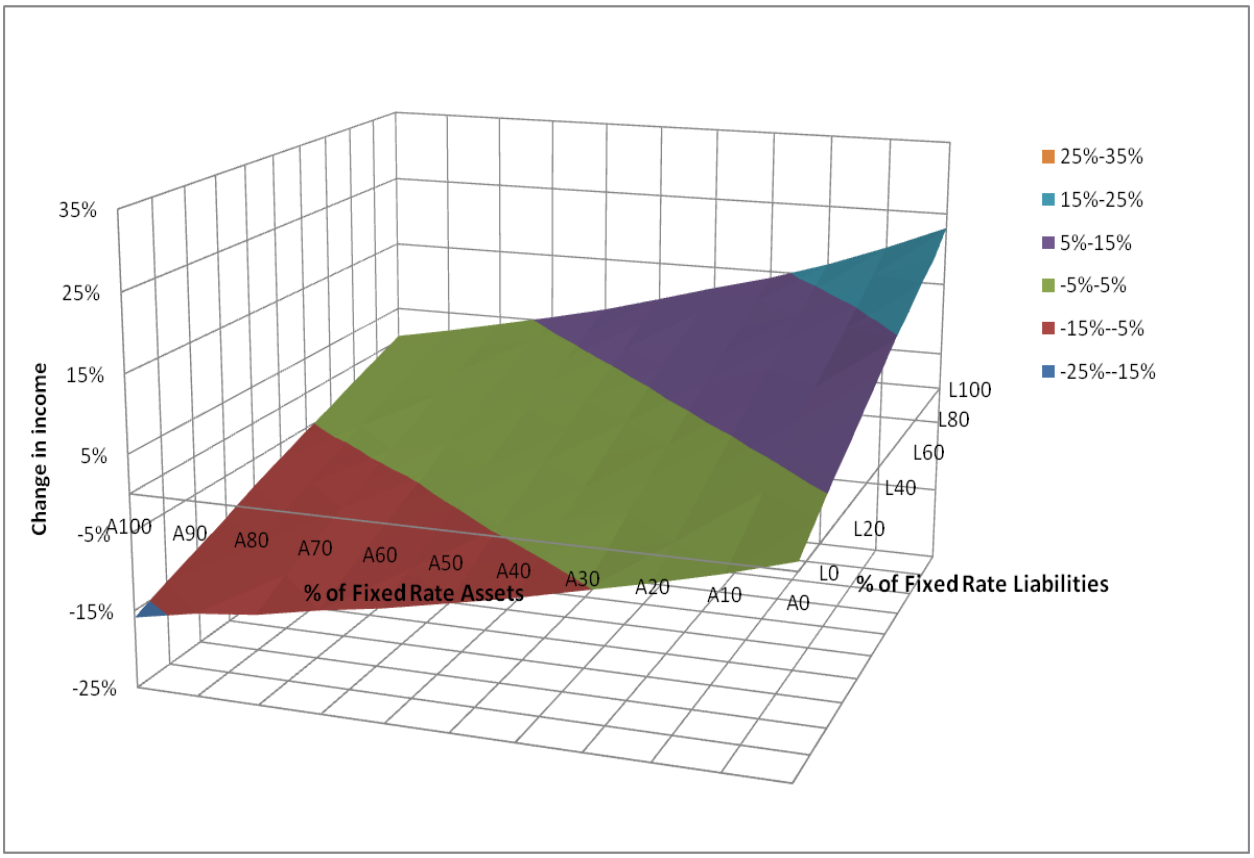


Figure 19: 3D graph of change in Type III Bank average income assuming 75 basis points expected rise in rates every year

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. This figure shows a 3D graph of changes in income for Type III bank given 75 basis points rise in interest rates. The surface shows 121 scenarios of structures of balance sheet. "A" represents fixed rate assets that could vary from 0% to 100%, and "L" represents fixed rate liabilities that also could vary from 0% to 100%. Percentage change in income shows the difference in income when there was no change in rates and when rates went up.

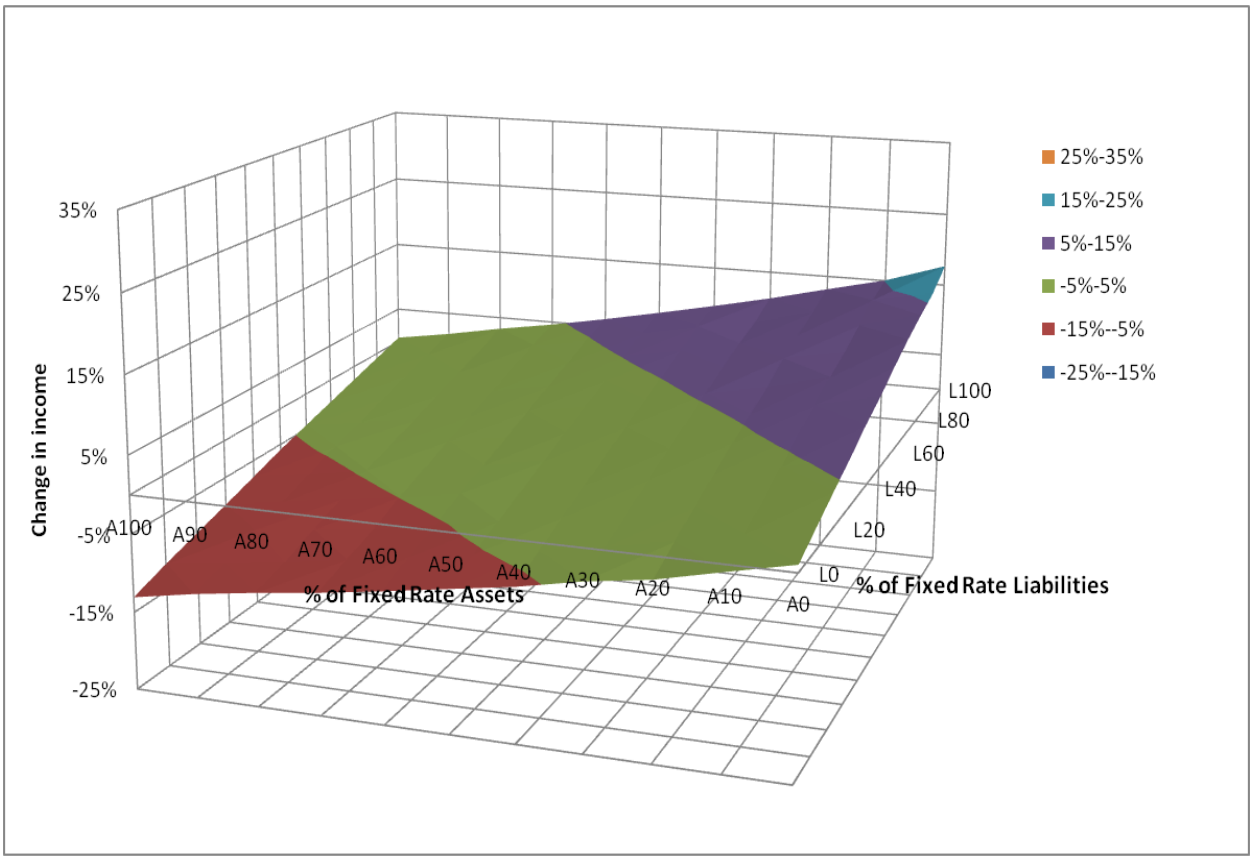


Figure 20: 3D graph of change in Type III Bank EBIT assuming 75 basis points expected rise in rates every year

Type III bank generates net interest income, traditional fee-based income and basic non-traditional fee-based income. This bank can be viewed as Type II bank plus some non-traditional services that are common in Canadian banks. Basic non-traditional services are brokerage, insurance, securitization, and mutual fund services. We deduct costs associated with non-traditional services from Type III bank income and simulate earnings before interest and taxes (EBIT).This figure shows a 3D graph of changes in EBIT for Type III bank given 75 basis points rise in interest rates. The surface shows 121 scenarios of structures of balance sheet. "A" represents fixed rate assets that could vary from 0% to 100%, and "L" represents fixed rate liabilities that also could vary from 0% to 100%. Percentage change in income shows the difference in income when there was no change in rates and when rates went up.

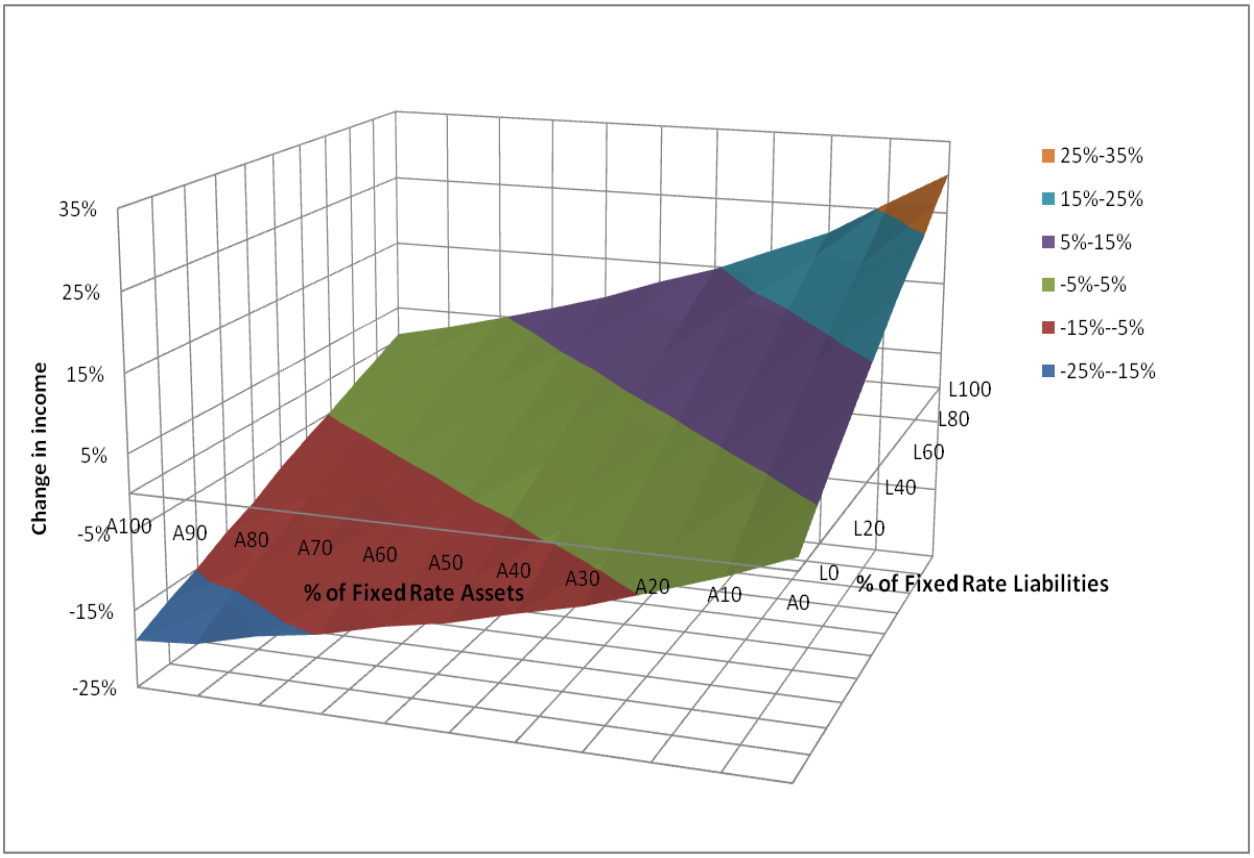


Figure 21: 3D graph of change in Type IV Bank average income assuming 75 basis points expected rise in rates every year

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated through investment management, underwriting services, and trading. This figure shows a 3D graph of changes in income for Type IV bank given 75 basis points rise in interest rates. The surface shows 121 scenarios of structures of balance sheet. "A" represents fixed rate assets that could vary from 0% to 100%, and "L" represents fixed rate liabilities that also could vary from 0% to 100%. Percentage change in income shows the difference in income when there was no change in rates and when rates went up.

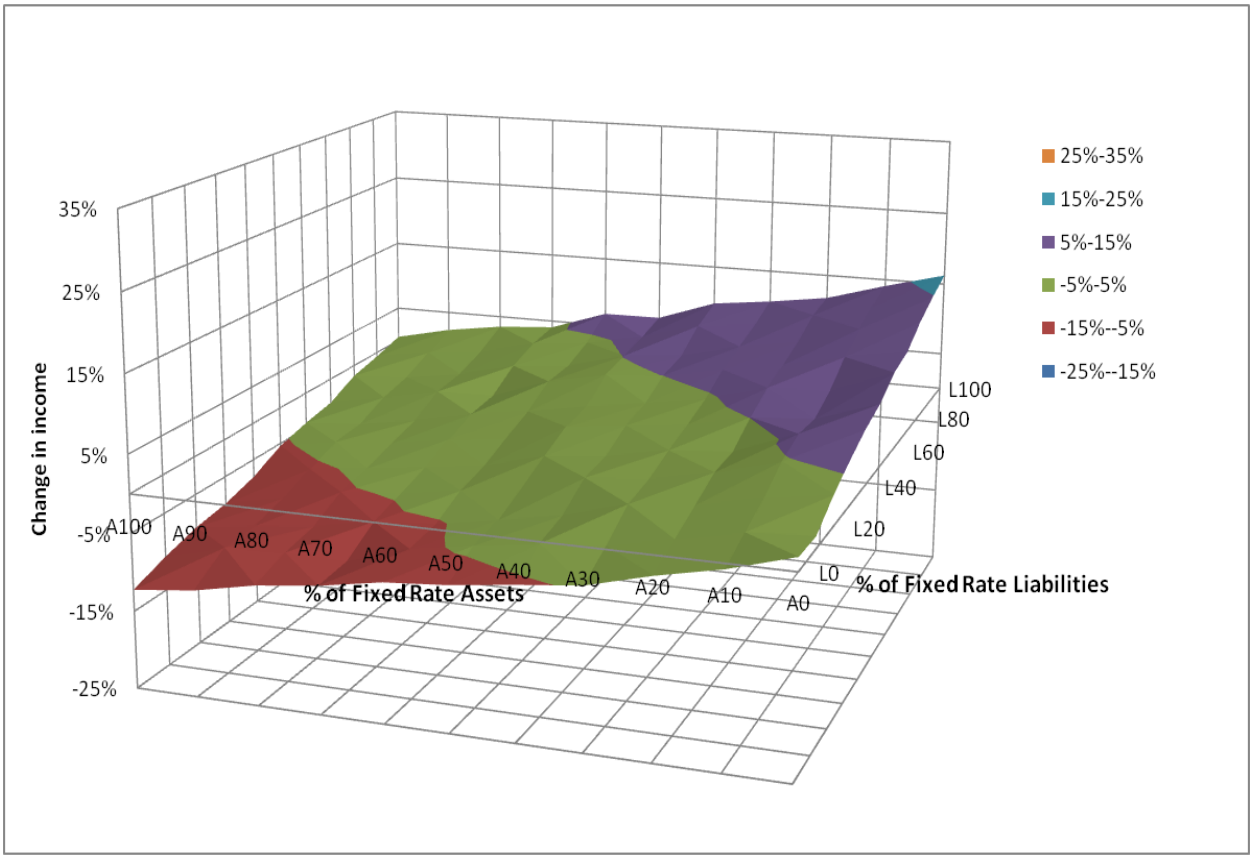


Figure 22: 3D graph of change in Type IV Bank EBIT assuming 75 basis points expected rise in rates every year

Type IV bank generates net interest income and all kinds of fee-based income: traditional, basic nontraditional and advanced nontraditional. Advanced nontraditional income is generated through investment management, underwriting services, and trading. When we deduct costs associated with those fee-based income services, we obtain earnings before interest and taxes (EBIT).This figure shows a 3D graph of changes in EBIT for Type IV bank given 75 basis points rise in interest rates. The surface shows 121 scenarios of structures of balance sheet. "A" represents fixed rate assets that could vary from 0% to 100%, and "L" represents fixed rate liabilities that also could vary from 0% to 100%. Percentage change in income shows the difference in income when there was no change in rates and when rates went up.